TOPCON

mmGPS 3D Paver

Reference Manual

TOPCON
POSITIONING SYSTEMS

mmGPS 3D Paver Reference Manual

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Table of Contents

Preface vii
Terms and Conditions vii
Manual Conventions ix

Chapter 1
Introduction 1-1
mmGPS 3D Paver Components 1-1
Jobsite Components 1-3
Hand-held Controller with Pocket-3D 1-5
Machine Components 1-6
Daily Care and Preventative Maintenance 1-18

Chapter 2
Setting up the Jobsite and Pocket-3D 2-1
Hand-held Controller and Pocket-3D 2-1
Setting Up the Base Station 2-2
Base Station Initialization 2-9
General Base Station Setup Rules and Notes 2-11
Setting up PZL-1 2-12
Equipment Setup: GPS 2-15
Step 1: Create a Control Point File 2-15
Step 2: Setup and Initialize a Base Station/Transmitter 2-17
Step 3: Create a Range Pole Equipment Configuration 2-19
Step 4: Setup the Rover Radio 2-21
Step 5: Setup the Rover Antenna 2-22
Step 6 for mmGPS: Setup the mmGPS Receiver 2-22
Step 7: Connect to the Rover 2-23
Localizing with Pocket-3D 2-24
Creating Files in Pocket-3D 2-25
Creating a Points File 2-25

Creating a Linework File 2-27
mmGPS Operations with Pocket-3D 2-28
Performing a Resection 2-28
Checking the Transmitter's Height 2-30
Transmitter Adjustment 2-32

Chapter 3
Setting up the Machine and 3DMC 3-1
9168 Control Box Buttons and Features 3-2
Front Panel 3-2
Back and Side Panels 3-6
Connectors 3-8
3DMC 3-9
Using 3DMC 3-10
Topcon Logo Key 3-12
File Menu 3-14
Control Point Files 3-14
Selecting a Control Point File 3-15
Creating a Control Point File 3-15
GPS Localization 3-19
Principles of GPS Localization 3-19
Entering Localized GPS Coordinates 3-21
Surface Files 3-23
Working Surface Display Options 3-25
Selecting Surface Files 3-26
Editing a Plane Surface File 3-27
Creating a Flat Plane Surface 3-28
Creating a Sloping Plane Surface 3-30
Raising or Lowering the Existing Surface 3-35
Creating a Subgrade of the Existing Road 3-37
Alignment Display Options 3-40
Linework Display Options 3-41
Point Display Options 3-42
Changing the Background Color 3-43
Point Files 3-44
Exit 3DMC 3-45
Control Menu 3-45
Machine Setup 3-45

Selecting a Machine Configuration 3-46
Creating a Machine Configuration 3-47
Steer Indication 3-51
Steer to Polyline 3-51
PZS-MC Receiver 3-53
PZL-1 Transmitters 3-54
Copying PZL-1 Transmitter Information 3-55
Calibrate Sensors (Averaging) 3-56
Averaging Value Range: 1-100 3-56
Valve Offsets 3-57
2D Control 3-59
Tools Menu 3-59
Topo Survey 3-59
Position Check 3-61
Configure Radios 3-63
View Menu 3-64
Main Window 3-65
Left Window 3-67
Right Window 3-68
Lower Window 3-69
Display Options 3-71
About 3DMC 3-72
Changing Cut/Fill Offsets 3-73
Changing the Grade Indicator 3-73
Changing the Light Bar Scale 3-75
Elevation Control Key 3-76
Adjust Elevation in mmGPS Control 3-78
Adjust Elevation in 2D Control 3-79
Changing Offsets Using the Elevation Control Key . 3-79
Adjusting Valve Gain 3-81
Viewing GPS Information 3-82
GPS Status and Quality 3-83
Screed Edge Position 3-83
Monitor Satellites and Enter Mask Angle 3-84
View Receiver Information or Reset Receiver ... 3-84
Satellite Planning Information 3-85
Viewing and Updating 3DMC Options 3-86
Setting the Elevation Offset and Locking On-grade . 3-87

Slope Control Key 3-88
Adjust Slope in mmGPS Control 3-89
Adjust Slope in 2D Control 3-90
Setting the Slope Offset and Locking On-grade 3-91
Pop-up Menu 3-92
Changing Control Methods 3-92

Chapter 4
Paving Principles 4-1
Paver Components 4-1
How a Screed Works 4-2
Tow Point Force (“P”) 4-5
Truck Exchange, Another Tow Point Force 4-6
Head of Material (“M”) 4-7
Reaction of Material Under Screed (“R”) 4-8
Gradation Mix Characteristics 4-9
Mix Temperature Characteristics 4-11
Weight of Screed (“W”) 4-12
Quality of Base Being Paved 4-13
Rolling Techniques 4-14
Controlling Mat Quality 4-14

Chapter 5
Getting Started 5-1
Equipment Setup and Initialization: Base Station 5-2
Equipment Setup and Calibration: PZL-1Transmitter 5-3
Equipment Setup: Machine Components 5-6
PZS-MC Setup 5-7
Screed and Antenna Measurements 5-9
Radio Antenna Installation 5-10
MC-2.5 Receiver Box Setup for mmGPS Applications 5-11
Control Box Setup 5-12
3DMC Setup 5-13
Setting up the PZL-1Transmitter in 3DMC 5-14
Machine Sensor Calibrations 5-15
Calibrating the Sensors Using the Slope Control Key 5-15
Setting the Valve Offsets 5-16
GPS Localization 5-18

Principles of GPS Localization 5-18
Entering Localized GPS Coordinates 5-20
Control Methods 5-23
mmGPS Control 5-23
Placing Transmitters at the Jobsite 5-24
Using Multiple Transmitters 5-26
Slope Control 5-26
Sonic Control 5-29
Laser Control 5-30

Chapter 6
2D Paving Applications 6-1
Using Sonic Control at the Jobsite 6-1
Step 1: Attach the Sonic Tracker 6-2
Step 2: Set up 9168 Control Box 6-5
3DMC Operations for Sonic Tracker Applications .. 6-7
Creating a 2D Machine Configuration File 6-7
Care and Maintenance of the Sonic Tracker 6-9
Sonic Tracker II Transducer Cleaning 6-9
Sonic Tracker II Transducer Replacement 6-10
Paving City Streets with Sonics 6-16
Paving City Streets with Cross Slope 6-18
Paving Streets Through Intersections 6-20
Method 1 for Paving Intersections 6-21
Method 2 for Paving Intersections 6-22
Paving Intersections with Cross Slope 6-24

Chapter 7
Troubleshooting 7-1
Base Station 7-2
MC-2.5 Receiver Box 7-4
GPS Localization 7-6
9168 Control Box 7-9

Appendix A
Safety Information A-1
General Precautions A-1
Radio Usage Information A-3

Appendix B
Specifications B-1
Control Box B-1
Blade Slope Sensor B-3
Simple Auto/Manual Knob B-4
MC-2.5 Receiver Box B-5
PZS-MC Sensor B-7
GPS Vibration Pole B-8
Trackerjack Vibration Pole B-9
Laser Tracker B-10
Trackerjack B-12
Sonic Tracker II B-13

Appendix C
Regulatory Information C-1
UHF Radio Usage C-1
FCC Compliance C-2
Community of Europe Compliance C-3
Canadian Emission Labeling Requirements C-3
WEEE Directive C-4

Appendix D
Warranty Terms D-1

Appendix E
Glossary E-1

Index

Preface

This manual has been developed to provide the operator with information necessary to operate and maintain TOPCON products. Proper service and use is important to the reliable operation of the equipment. The procedures described herein are effective methods for performing service and operation of this system.

Please read these Terms and Conditions carefully.

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Mercury Warning

The LCD display in the 9168 Topcon Control Box contains mercury. The Control Box should not be disposed of or placed in a waste stream destined for disposal until the mercury is removed and reused, recycled, or otherwise managed to ensure that the mercury in the product does not become mixed with other solid waste or wastewater.

Manual Conventions

This manual uses the following conventions:

Example	Description
File ▸ Exit	Click the **File** menu and then click **Exit**.
Connection	Indicates the name of a dialog box or screen.
Frequency	Indicates a field on a dialog box or screen, or a tab within a dialog box or screen.
Enter	Press or click the button or key labeled **Enter**.

Supplementary information that can help to configure, maintain, or set up a system.

Supplementary information that can have an affect on system operation, system performance, measurements, personal safety.

Notification that an action has the potential to adversely affect system operation, system performance, data integrity, or personal health.

Notification that an action *will* result in system damage, loss of data, loss of warranty, or personal injury.

Under no circumstances should this action be performed.

Introduction

mmGPS 3D Paver is a complete, non-contacting control system which combines elevation control and slope control into a simple, easy to use package. Coupled with the precision of mmGPS, paving applications gain greater control over mat thickness and material management.

The mmGPS 3D Paver system provides multiple 3D and 2D options for control applications (Figure 1-1). Regardless of the option(s) selected, the control box analyzes design data and cross references it with current sensor data to provide real-time information for immediate operator and/or hydraulic response.

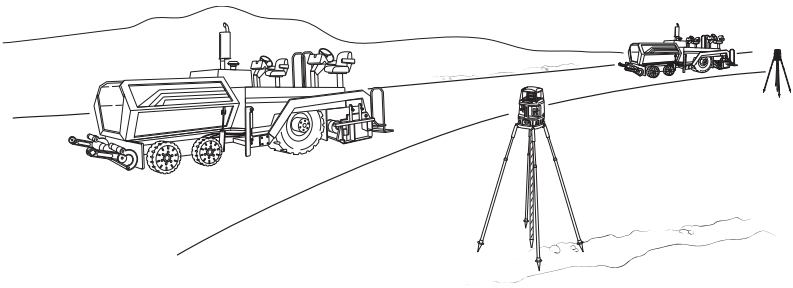
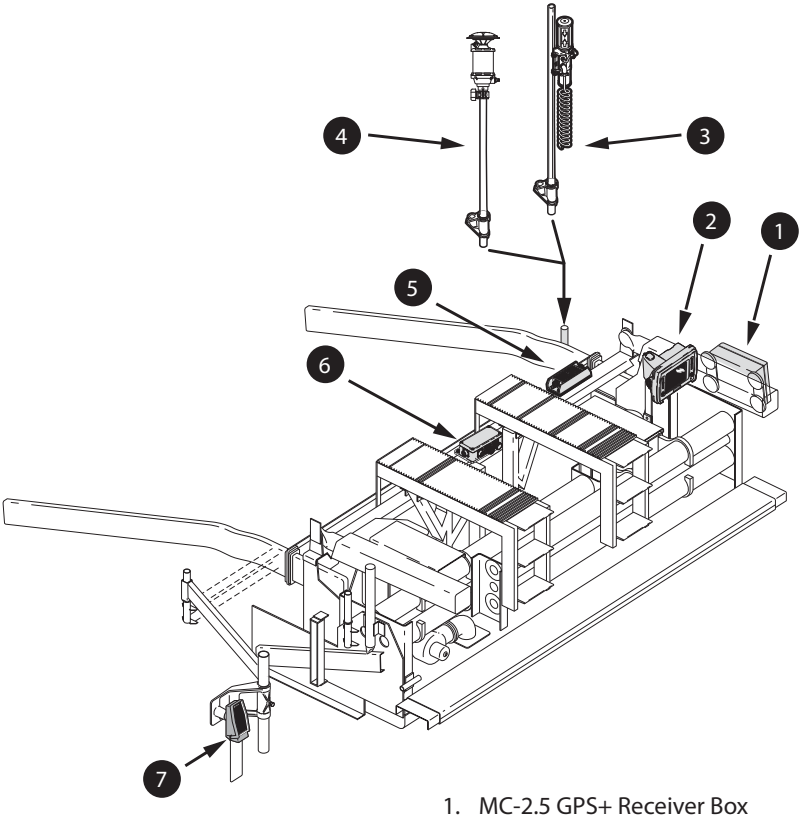


Figure 1-1. mmGPS 3D Paver Components

mmGPS 3D Paver Components

The mmGPS 3D Paver system includes various hardware options for controlling mat thickness, including sonic, laser, slope, and mmGPS solutions. The 9168 control box, in conjunction with 3DMC software, provides a visual interpretation and on-the-fly control of the jobsite, as well as real-time elevation/slope information (Figure 1-2 on page 1-2).

Figure 1-2 displays the setup of components on a screed.



1. MC-2.5 GPS+ Receiver Box
2. 9168 Control Box
3. Laser Tracker & Trackerjack
4. mmGPS PZS-MC
5. Slope Sensor
6. Junction Box
7. Sonic Sensor II

Figure 1-2. mmGPS 3D Paver Component Placements

Jobsite Components

Topcon's LazerZone™ and Millimeter GPS™ (mmGPS) products provide unparalleled measuring accuracy at the jobsite, and is up to 300% more accurate than standard GPS. The LazerZone transmitter provides wide vertical measurement area of 600m/2000ft diameter and 10m/33ft height. The system provides multiple rover support for machine and pole mounted sensors, and the technology works with existing Topcon GPS+ systems.

Base Station Kit The Base Station Kit (Figure 1-3) sends position corrections to an unlimited number of machines or survey Rovers. The kit includes Topcon's Legacy-E+ receiver (with PG-A1 antenna and external radio modem) or a HiPer brand receiver, tribrach, cables, and a hard carrying case.

The type of options on the Base Station kit can be customized based on individual needs; some kits support GPS+ positioning with RTK measurement and others support normal GPS positioning with RTK measurement. If used with a portable foundation, like a tripod, daily setup and daily height measurements are required.

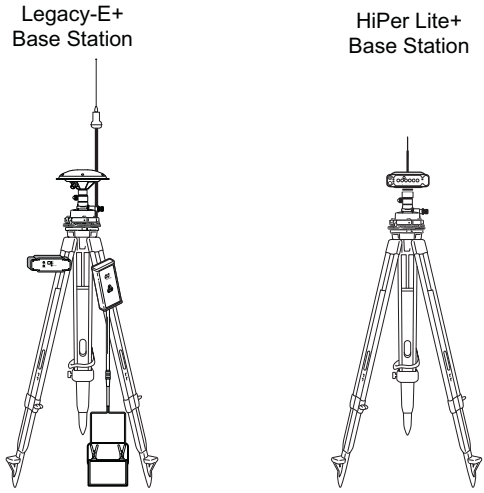


Figure 1-3. Base Station Kit

PZS-1 Sensor and GPS+ Receiver (optional) The PZS-1 sensor (Figure 1-4) instantly computes precise vertical information from the PZL-1 laser transmitter. Using Lazer Zone technology, the PZS-1 automatically determines elevation based on jobsite control. Mounting the PZS-1 to a range pole and attaching a GPS+ receiver allows the sensor to receive the PZL-1 laser signal and wirelessly transmit data to the receiver.

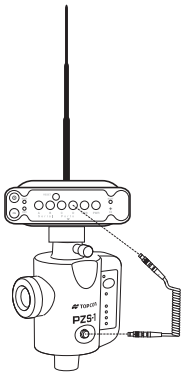


Figure 1-4. Receiver and PZS-1

PZL-1 Laser Transmitter The PZL-1 laser transmitter (Figure 1-5) operates similar to a standard rotating laser, but transmits a unique signal to provide a working range of 2000ft and a measuring area of 33ft in height. Up to four laser transmitters can be linked for use on large sites. Each PZL-1 laser transmitter also supports multiple rovers, even at different elevations for continuous production.

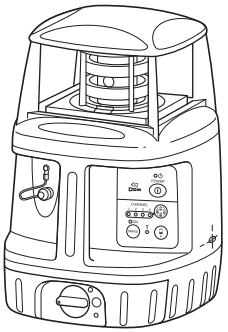


Figure 1-5. PZL-1 Laser Transmitter

Hand-held Controller with Pocket-3D

Optional field software for all control applications, Pocket-3D assists superintendents, operators, or grade checkers when staking or checking grade on a site. This software runs on a portable hand-held controller (Figure 1-6 on page 1-6) and uses files common with other equipment on the job site, allowing multiple users to work at the same time. This software is required for some mmGPS operations.

Using Pocket-3D on a portable hand-held controller, you can:

- Set up the Base Station, the mmGPS Transmitter, and the mmGPS Rover
- Create and edit Control Point files and Design Surface files
- Create and edit Machine Configuration files and radio configuration files
- Create and edit Point files and Linework files
- Import and export files
- Perform stakeouts and grade checks
- Perform topographic surveys

When enabled for mmGPS, Pocket-3D has the following added functionality:

- Set up machine files for mmGPS equipment
- Set up the PZS-1 sensor
- Check the height of the transmitter
- View a history of surface activity

To enable Pocket-3D for mmGPS, contact your local Topcon representative to obtain the upgrade.

Figure 1-6. Pocket-3D (Main Screen) on the FC-100

Machine Components

Regardless of the application, the machine requires the following components.

PZS-MC Sensor The PZS-MC sensor (Figure 1-7 on page 1-7) replaces the machine-mounted GPS antenna. The PZS-MC sensor combines the MC-A1 GPS antenna with laser sensor technology into a total package. LazerZone™ technology allows the sensor to detect up to four different PZL-1 laser transmitters for increased range. The sensor attaches to a GPS vibration pole on the machine blade, and cables connect the receiver to the MC-2.5 Receiver Box for sending corrections to the 9168 control box.

Dummy connectors are **Sold Separately.** They do not come in the Kit.

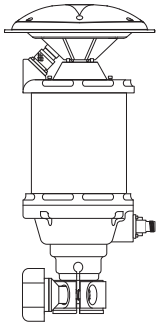


Figure 1-7. PZS-MC Machine Control mmGPS Sensor

GPS Vibration Pole The GPS vibration pole (Figure 1-8) installs on the machine, sliding onto the pivot post attached to the tow arm. The GPS vibration pole provides a lightweight, fixed mount for the PZS-MC, and utilizes shock isolation and vibration dampening.

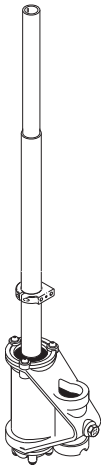


Figure 1-8. GPS Vibration Pole

Slope Sensor The slope sensor (Figure 1-9 on page 1-8) is a precision electronic sensor which functions much like a precision carpenter's level. The slope sensor reads the inclination (tilt) of the screed and sends the signal to the control box. The slope sensor measures slopes from +20% to -20%

The slope sensor connects to the control box through an electrical cable and requires no adjustments, and can be used to control either side of the paver. The slope sensor is a sealed component, and once attached to the Paver, should not be removed.

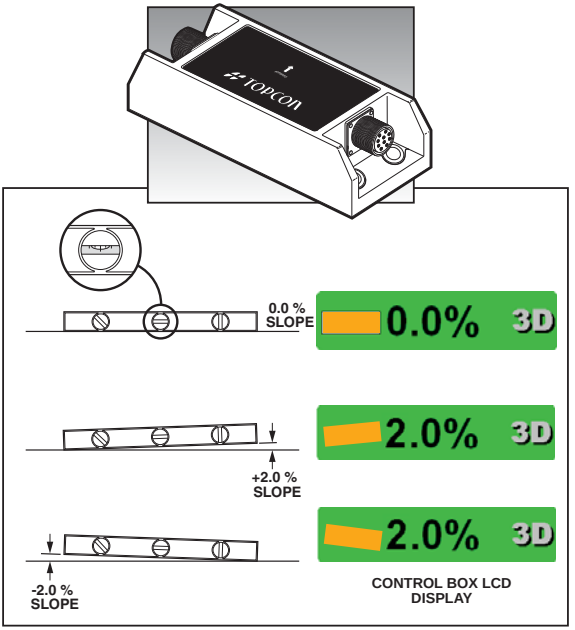


Figure 1-9. Slope Sensor

mmGPS 3D Paver Junction Box The junction box (Figure 1-10 on page 1-9) allows the various components and hydraulics to be linked together for accurate paving. The junction box and associated cables are installed when first installing the system onto a Paver. No adjustments are necessary, but ensure that caps are in place on unused connectors.

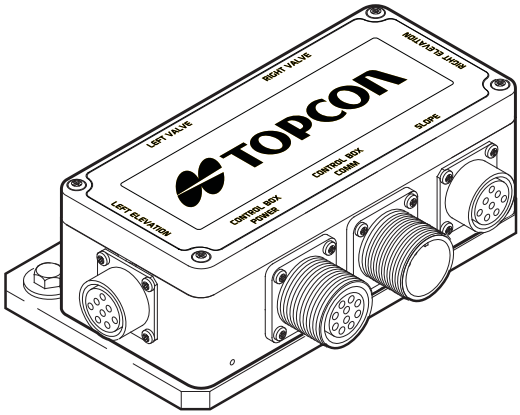


Figure 1-10. Junction Box

9168 Control Box The 9168 control box (Figure 1-11 on page 1-10) is the operator's interface, as well as the primary control for the mmGPS 3D Paver components. The 9168 control box combines the System Five platform with a computer graphic display into a single, rugged unit that provides dual hydraulic control for stakeless 3D GPS+, mmGPS, and 2D control.

- The high-resolution, bright touch screen display easily adapts to a variety of machine applications, providing the operator with easy-to-view graphical information.
- A mounting bracket and one side or double side clamps secure the control box to the machine. The clamps provide easy attachment at the beginning of the day and easy removal for storage in the carrying case at the end of the day.
- All cables attach in the back and remove easily with quick-disconnect connectors.

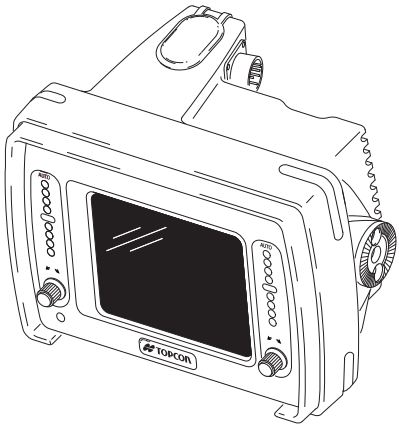


Figure 1-11. mmGPS 3D Paver 9168 Control Box

MC-2.5 Receiver Box The MC-2.5 Receiver Box (Figure 1-12 on page 1-11) attaches to the machine with shock isolated magnetic mounts. No manual adjustments are required and it can be removed at the end of the day for storage.

The MC-2.5 Receiver Box combines Topcon's GPS receiver module and a radio module into a single, rugged housing.

- When used in conjunction with the PZL-1 laser transmitter and the PZS-MC sensor, the MC-2.5 Receiver Box provides 3DMC and the machine with millimeter level accuracy.
- When used in conjunction with a Base Station, the MC-2.5 Receiver Box provides 3DMC and operator with Real Time Kinematic (RTK) measurements.

3DMC processes these real time measurements to compute paving and graphical mapping information.

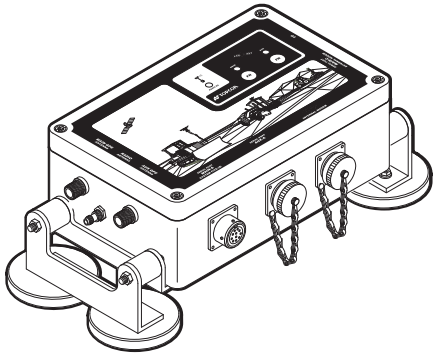


Figure 1-12. MC-2.5 Rover GPS Receiver Box

MC-2.5 Receiver Box Functions Three LED indicators on the MC-2.5 Receiver Box provides status on power, satellites, and radio signal (Figure 1-13 on page 1-12). Two function (FN) buttons provide diagnostic and reset for the internal receiver boards.

- Radio RX LED – radio status indicator. This LED blinks green when receiving data from the Base Station, typically once per second.
- Main LED and FN Button – power and satellite indicator.
  - When the MC-2.5 Receiver Box is hooked up to power, but is not connected to a GPS antenna and therefore not tracking any satellites, only the red LED blinks.
  - When the MC-2.5 Receiver Box is attached to a GPS antenna, green blinks indicate the number GPS satellites being tracked while red blinks indicate GLONASS satellites. A pause precedes each repetition of blinks.
  - Pressing the FN button changes the Main receiver board's information mode between Normal Mode and Extended Information Mode. See below for details.

- Aux LED and FN Button – only active in Dual GPS applications.

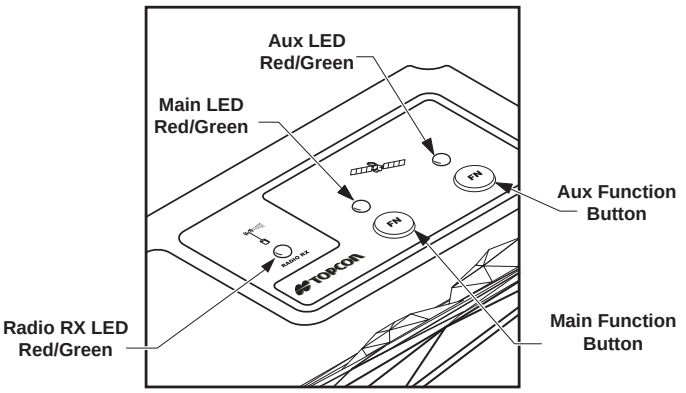


Figure 1-13. MC-2.5 Receiver Box Indicators

In normal mode, the LED indicates the number of tracked satellites and the position's computation status.

The MC-2.5 Receiver Box also has an extended information mode (EIM) used for receiver testing purposes. In this mode, the receiver continues to work as usual, but the LED indicates "extended" information using a delimiter. The delimiter is a distinguishable double-blink that shows the overall status of tests performed in EIM. The LED color for delimiter is calculated from the colors of other LED blinks.

- Orange – at least one blink is orange.
- Red – no orange blink and at least one red blink.
- Green – all other cases.

The delimiter double-blink is followed by six LED blinks corresponding to six receiver tests, where each blink indicates the following information:

Blink 1. Sufficient data for position computation.

Blink 2. GPS S/N ratios are good.

Blink 3. GLONASS S/N ratios are good.

Blink 4. Oscillator's frequency offset is less than three ppm.

Blink 5. Oscillator's Allan Variance is better than 2.7e-10.

Blink 6. Continuous tracking time is more than 15 minutes.

The color of the blink indicates that information for test is unavailable (orange), the receiver passed the test (green), or the receiver failed the test (red).

1. To switch to EIM, press and quickly release (within one second) the **Main FN** button.
2. Watch for the delimiter double-blink. With good receiver, antenna, and observation conditions, all blinks should be green within 15 minutes of powering on.
   - Green – ok
   - Orange – wait
   - Red – some tests failed
3. To switch back to normal mode, press the **Main FN** button.

Clearing the MC-2.5 Receiver Box NVRAM The receiver's Non-Volatile Random Access Memory (NVRAM) holds data required for satellite tracking, such as ephemeris[1] data and receiver position. The NVRAM also keeps the current receiver's settings, such as active antenna input, elevation masks and recording interval, and information about the receiver's internal file system.

Even though clearing the NVRAM is not a common (nor normally a recommended) operation, there are times when clearing the NVRAM can eliminate communication or tracking problems. Clearing the NVRAM can be interpreted as a "soft boot" of your computer.

After clearing the NVRAM, your MC-2.5 Receiver Box requires some time to collect new ephemerides and almanacs (around 15 minutes). Clearing the NVRAM of the MC-2.5 Receiver Box resets the box to factory default values.

In addition, the NVRAM is used to keep information about the receiver file system. Note that after clearing the NVRAM, the receiver's LED(s) flashes orange for a few seconds indicating that the receiver is scanning and checking the file system.

1. Ephemeris (ephemerides): Data giving the coordinates of a celestial body at specific times during a given period.

1. Turn off power to the MC-2.5 Receiver Box by unplugging the power cable.
2. Press and hold the **Main FN** key for a single box or the **AUX** key for a dual box (Figure 1-14).
3. Plug the power cable from the MC-2.5 Receiver Box to return power.

   The LED corresponding to the pressed FN key or AUX key turns green.
4. Wait until the Main LED blinks orange (about three seconds).

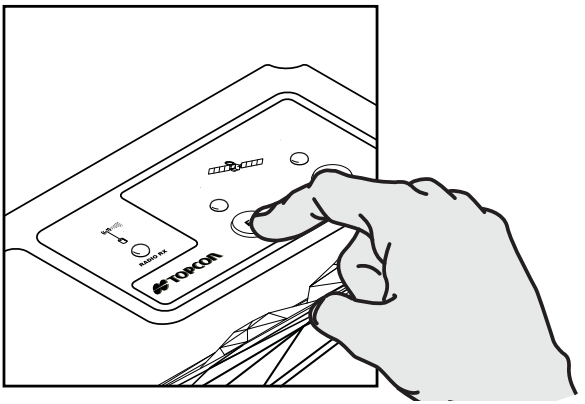


Figure 1-14. Hold FN Key While Turning PWR On to Clear NVRAM

5. Release the FN key or Aux key while the LED blinks orange.

The Radio Antenna The radio antenna is attached on the machine using a magnetic mount, and generally stays on the machine. The antenna should be positioned vertically and as high as possible on the machine to maximize signal reception (Figure 1-15 on page 1-15).

1. Attach the radio antenna to the roof of the machine.
2. Connect the radio antenna cable.

When the system has not been used for several days or months, the antenna might have been removed for storage or transportation. To reinstall the radio antenna, set it up as described above and ensure the magnet mount attaches to an even and smooth surface.

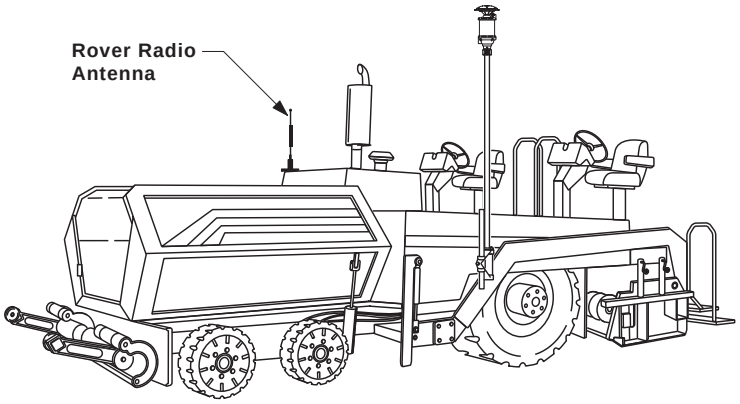


Figure 1-15. Machine Radio Antenna Setup

Simple Auto/Manual Knob The Simple Auto/Manual Knob (Figure 1-16) mounts on the control lever for easy access and allows the operator to switch between Automatic and Manual control.

- Automatic Control – Flip the switch forward to activate this control mode.
- Manual Control – Flip the switch backwards to activate this control mode.

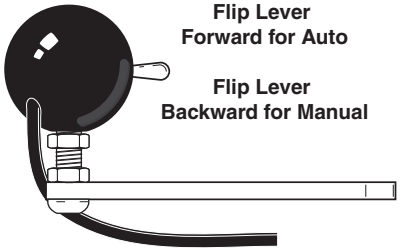


Figure 1-16. Simple Auto/Manual Knob

The knob is normally placed just below the control box for easy access, allowing the operator's hands to stay near the thickness cranks and screed controls.

In 2D control applications, the 9168 control box supports sonic and laser control applications.

Sonic Tracker II™ The Sonic Tracker II (Figure 1-17) measures and controls the elevations of the screed, and should be removed at the end of each day for proper storage in the carrying case. The Sonic Tracker contains no manual adjustments, and may require periodic maintenance of the transducer.

The Sonic Tracker measures distance, controlling grade from a physical grade reference, such as a curb, stringline or existing road surface. A transducer, located in the bottom of the Tracker, generates sound pulses like a speaker and listens for returned echoes like a microphone.

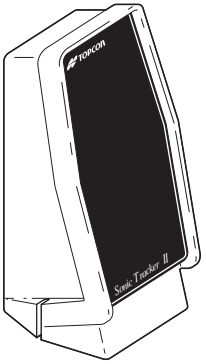


Figure 1-17. Sonic Tracker II

Trackerjack Vibration Pole The Trackerjack vibration pole (Figure 1-18) provides a sturdy, lightweight, fixed mount for the Laser Tracker and Trackerjack for use in rough applications.

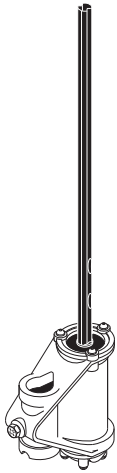


Figure 1-18. Trackerjack Vibration Pole

System Configuration Figure 1-19 shows the system configuration for the mmGPS 3D Paver.

Figure 1-19. mmGPS 3D Paver System Configuration

Daily Care and Preventative Maintenance

A good daily care and preventative maintenance routine prevents many problems before they occur. The most important part of daily care for the system is to clean it and keep it free of debris, and to thoroughly dry removable components (PZS-MC, Sonic Tracker II™, control box, and cables) before storing them in the carrying case. In addition, the following procedures ensures trouble free operation:

- Keep the carrying case clean and dry. Do not leave it open and exposed to the elements. Clean and dry all components prior to placing them into the carrying case.
- Keep the control box's touch screen clean to prevent scratching and from getting debris caught around the screen's edges.

A dirty screen or debris caught in the screen's edges can cause incorrect touch screen operation.

- Ensure that protective connector caps, provided on some components, are in place when not using the cables. Water accumulating on the connectors can cause electrical shorts.
- Place system cables in their appropriate storage connectors after removing the control box.
- Do not use high-pressure spray water steam cleaner hoses directly on cables and components. The components can be used in the rain or light spraying.
- Check for oil leaks in hydraulic assemblies and hoses.
- Check for loose components due to physical damage.
- Use proper battery supplies for components isolated from the machine (Base Station/Transmitter). Keep the machine's battery in good condition.
- Check the Sonic Tracker II™ Transducer daily to make sure the Filter Foam and Transducer are clean and free of debris. If the Filter Foam is clogged with dirt, replace it. If the Transducer appears to be covered with debris and performance is being

affected, clean or replace it using the steps listed in “Care and Maintenance of the Sonic Tracker” on page 6-9.

Notes:

Setting up the Jobsite and Pocket-3D

Pocket-3D field software, which is required for some mmGPS operations, runs on a portable hand-held controller and uses files common with other equipment on the jobsite. Using Pocket-3D allows multiple users to work at the same time.

Hand-held Controller and Pocket-3D

Pocket-3D is grade and staking control software for hand-held controllers. At the jobsite, Pocket-3D provides a way to make quick changes and updates to files, double-check control points, initialize the GPS base, and many other useful functions.

3DMC and Pocket-3D save files in the same format, which makes it easier for surveyors, machine operators, and grade checkers to share files and to update software.

Refer to the *Pocket-3D User's Manual* and *Pocket-3D Reference Manual* for further details.

Before performing any Pocket-3D configuration or application function, check the units used at the job. Units are the method of measurement used for measuring various data. To check, change, or apply units to the project, tap **Setup ▸ Units** (Figure 2-1 on page 2-2).

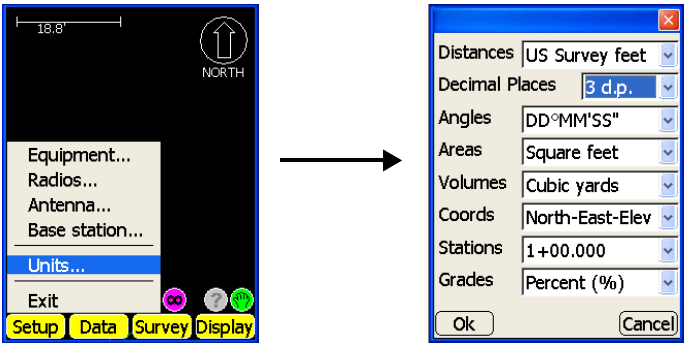


Figure 2-1. Setup Units

Setting Up the Base Station

The Base Station can be set up and taken down on a daily basis, or mounted on a permanently fixed pole and left for the duration of the project. A permanent setup prevents errors due to incorrect antenna height measurements.

When setting up the Base station, make sure you select the correct point from the control points file and verify the point has a northing, easting, and elevation coordinate. The more accurate these coordinates are, the tighter the control while grading.

Use the following checklist for quick setup of the Base Station.

- ☐ Select a control point and install the Base station over it.
- ☐ Measure the antenna height.
- ☐ Connect all Base Station components and cables.
- ☐ Select the correct radio settings. Refer to your Base Station's documentation for specific radio configuration procedures.

  The Base and Machine must use the same radio settings.
- ☐ Initialize the Base station.

Once you have set up the Base Station, simple checks at the machine ensure the machine receives corrections from the Base station: if the elevation control key is green, the Base Station is ready.

Figure 2-2 on page 2-4 shows a completed Base Station setup.

Use a plumb bob for quick and easy setup of the tripod, especially if the ground is uneven.

Step 1: set up the tripod and GPS receiver/antenna over a control point, accurately level the tripod as described below.

1. Over a control point, extend the extension legs of the tripod to suitable lengths. Tighten the leg screws.
2. Attach the universal tribrach to the tripod, securing it in place (Figure 2-2 on page 2-4) and insert the tribrach adapter into the tribrach.

3. Insert the horizontal spacer into the adapter and securely attach the GPS antenna to the spacer.

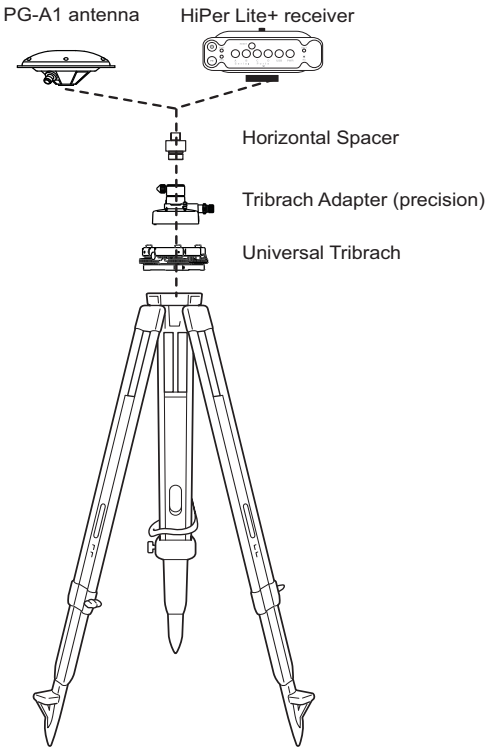
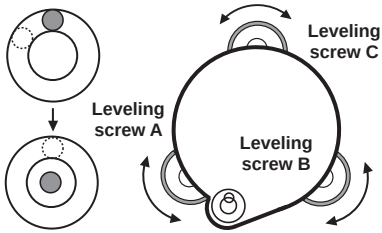


Figure 2-2. Base Station Setup

4. Roughly Level the Antenna Using the Circular Level.

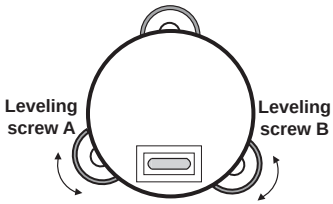
   Turn leveling screws A and B to move the bubble in the circular level. The bubble is now located on a line perpendicular to a line running through the center of leveling screws A and B.



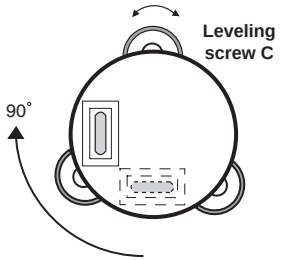
Turn leveling screw C to center the bubble in the circular level.

5. Center Using the Plate Level.

   Rotate the instrument horizontally using the horizontal motion/ clamp screw and place the plate level parallel with the line connecting leveling screws A and B. Turn leveling screws A and B to bring the bubble to the center of the plate level.



Rotate the instrument 90° around its vertical axis and turn leveling screw C to center the bubble once more.

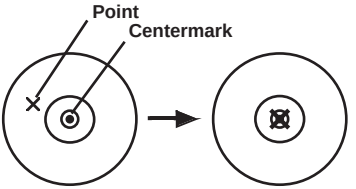


Repeat step 4 for each 90° rotation of the instrument and check that the bubble correctly centers at all four points.

6. Center Using the Optical Plummet Telescope.

   Adjust the eyepiece of the optical plummet telescope to your eyesight.

Slide the instrument by loosening the tripod screw, place the point on the center mark, and then tighten the tripod screw. Slide the instrument carefully to prevent any dislocation of the bubble.



7. Level the Instrument.

   Level the instrument as in step 4. Rotate the instrument, checking that the bubble is in the center of the plate level, regardless of telescope direction. Then tighten the tripod screw to lock in position.

Step 2: attach additional components to the tripod (Figure 2-3 on page 2-7).

Attach and/or prepare additional Base Station components. These components vary, depending on the type of Base Station.

- For the PG-A1 Base Station, attach the radio modem, radio antenna, MC-2.5 Receiver Box, and power source (optional).
- For the HiPer Lite+ Base Station, attach a power source (optional).

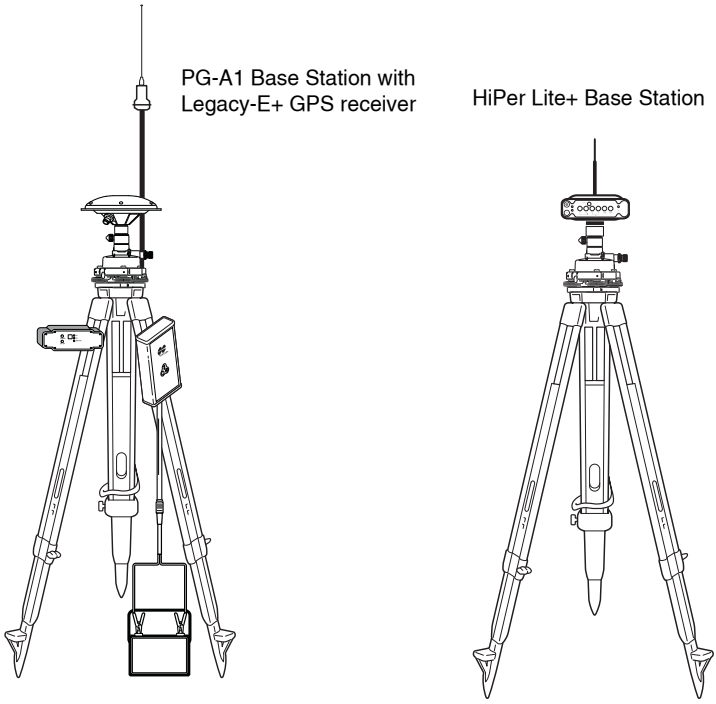


Figure 2-3. Base Station Setup

Step 3: connect component cables to the receiver (Legacy-E+ or HiPer Lite+), then connect the cables to other components (Figure 2-4 on page 2-8).

- If using Bluetooth wireless technology to connect a controller and the HiPer Lite+ receiver, refer to the controller's or receiver's documentation.
- Connect the following cables for the following components to the Legacy-E+ receiver, then to the component:
  - GPS antenna: connect the antenna cable to the receiver's ANT port, then to the GPS antenna.
  - Power: connect the power cable to the receiver's PWR1 or PWR2 port. Attach the alligator clamps to the battery: RED to positive, BLACK to negative.

– Radio Modem: connect the radio modem cable to the receiver's port C and the radio modem. Connect the other end to the battery.

– Controller: connect the cable with 7-pin circular connector to the receiver's port A. Connect the other end of the cable to the controller. The controller initializes the Base Station. See "Base Station Initialization" on page 2-9 for details.

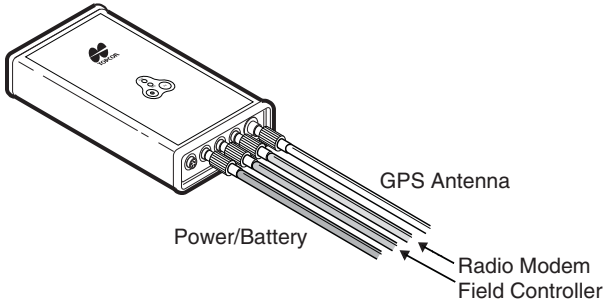


Figure 2-4. PG-A1 Base Station Cable Connections

Step 4: start the Base Station

1. Turn on the controller. For a PG-A1 Base Station, turn on the radio and select the correct channel on the radio modem.
2. Press the **PWR** button on the GPS receiver for one to two seconds. The power LED flashes red then rapidly green.

   Once powered up, the number of successive red and green flashes indicates the number satellites being tracked.

   - GPS – only green flashes
   - GPS+GLONASS – green flashes followed by red flashes

To turn off the receiver, press the **PWR** button for one to two seconds until LEDs are off.

Step 5: measure the antenna height from the control point to the rim (slant) or ARP (vertical) of the antenna (Figure 2-5 on page 2-9).

This measurement is used when initializing the Base Station.

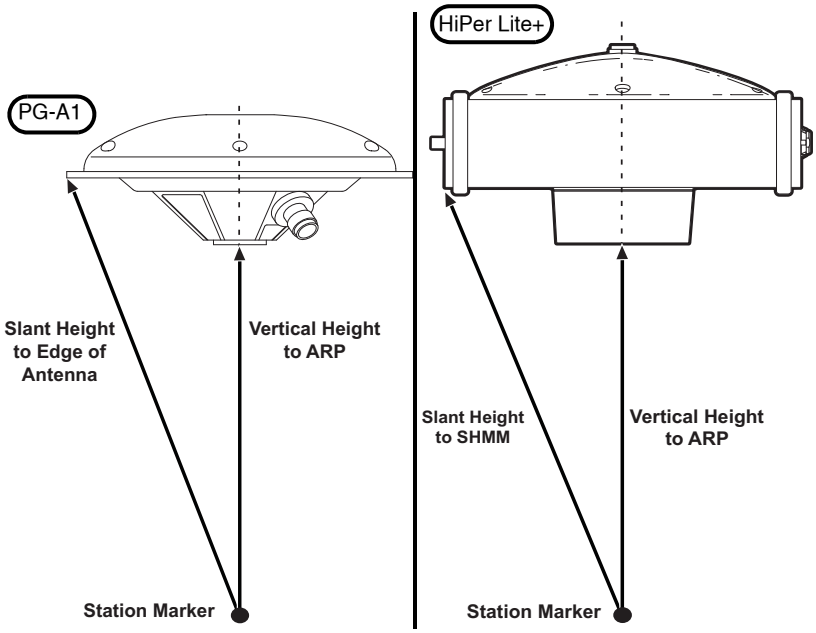


Figure 2-5. Measure Base Station Antenna Height

Base Station Initialization

Before initializing the Base Station, check the Units used in the current jobsite (Setup ▸ Units) and that the correct Control Point file is selected (Data ▸ Control). Figure 2-6 on page 2-10 shows the procedure listed below.

1. Connect the controller and receiver. Tap **Setup ▸ Base station**.
2. Select the control point over which the Base Station is installed and the connection between controller and receiver. Press **Next**.
3. Enter antenna type and height information. Press **Ok**.
4. Enter radio type and communication information. If using a Pacific Crest PDL UHF radio, press **Configure** to select channel information and press **Set**. Press **Next**.
5. Press **Finish** to initialize the GPS receiver and start the Base.

6. Immediately disconnect the Pocket-3D controller from the receiver.

CAUTION

Performing any other activities while connected to the Base Station converts the Base to a Rover.

7. Check that the TX LED on the Base radio flashes once a second. This indicates data transmission.

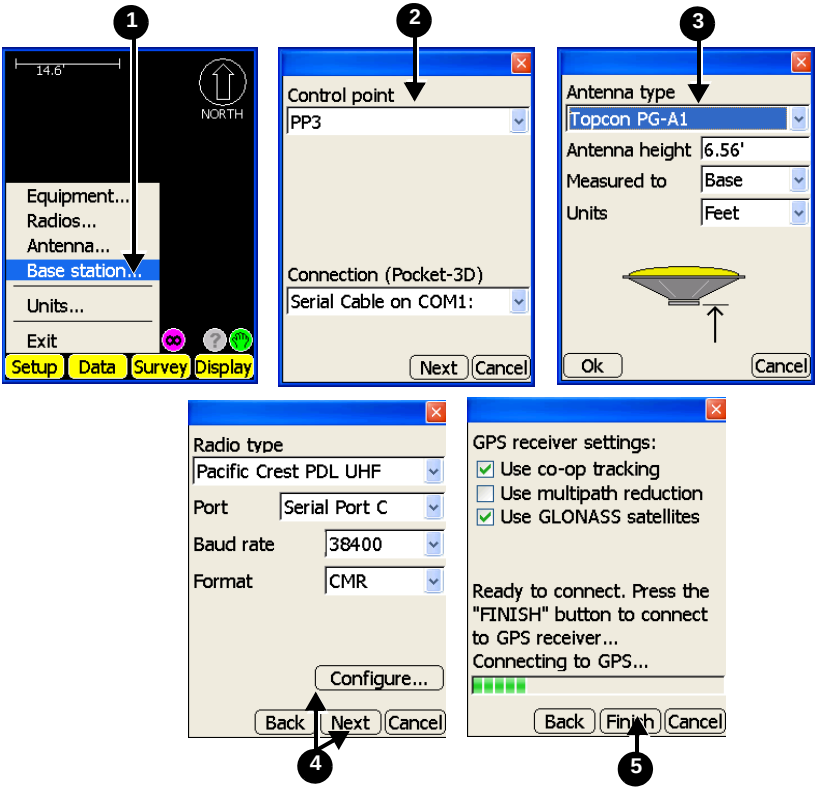


Figure 2-6. Enter Base Station Information and Start Base – PG-A1 and Legacy-E+ Example

General Base Station Setup Rules and Notes

- Every time the Base Station is setup, a new slant measurement must be taken since the height of the antenna is different, unless using a fixed-height tripod, or other permanent mount. If using a permanent mount, you only need to measure the height of the antenna once and initialize the Base Station once using Pocket-3D. The Topcon receiver remembers the initial settings. However, if any setting stored in the receiver has been changed or initialized (like a reset function), you need to re-initialize the Base Station.
- When the receiver tracks a sufficient number of satellites, the receiver takes only a few seconds to process and report a successful start. See Chapter 7 if the receiver fails to respond or fails to initialize.
- Ideally, the Base Station should be placed in an area free of objects that can obstruct signals from satellites and degrade positioning accuracy. Obstructions can include trees, buildings, vehicles, or fences.
- Ideally, the radio antenna should not be placed too close to the receiver. For large job sites, or sites with hilly terrain, use a tall tripod or a sturdy structure to raise the radio antenna as high as possible for better radio transmission range.

Setting up PZL-1

For machine control applications, the PZL-1 transmitter attaches to either a standard tripod or a fixed 2m tripod over a surveyed point. To locate the transmitter over an unknown point, see “Performing a Resection” on page 2-28.

The following setup requires Pocket-3D to activate and initialize the transmitter. For more information on the Pocket-3D software, refer to the *Pocket-3D User’s Manual* and *Pocket-3D Reference Manual*.

1. Locate a control point over which to set up the PZL-1 laser transmitter.

See page 2-4 for detailed notes on how to setup and level a tripod.

2. Attach the transmitter to the tripod.
3. Turn on the transmitter’s power and select a channel for the transmitter (Figure 2-7 on page 2-13).

   To assign a channel to the transmitter, press the channel button until the corresponding LED lights up.
4. Connect the transmitter and Pocket-3D controller (Figure 2-7 on page 2-13).

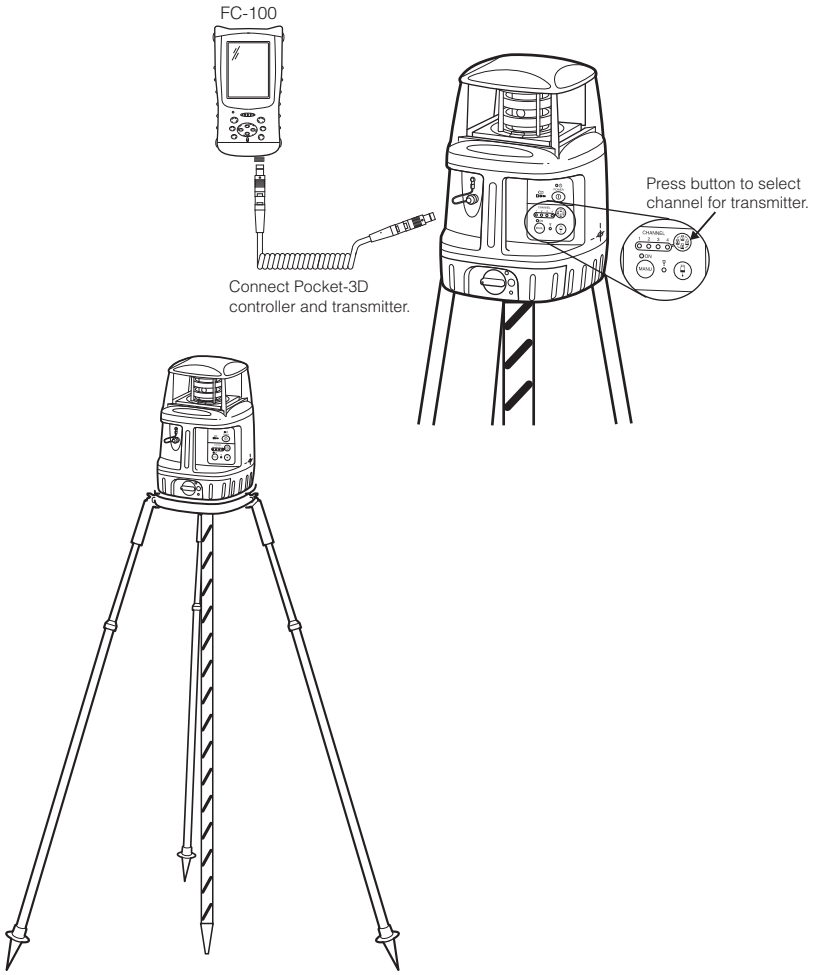


Figure 2-7. Setup PZL-1 Laser Transmitter, Select Channel, and Connect Controller

5. In Pocket-3D, check that a mmGPS-enabled machine configuration is loaded. Then tap **Setup ▸ mmGPS Transmitters** to set up from one to four transmitters.

6. On the *Transmitters* tab, select the connection method used between the controller and transmitter. Then perform one of the following functions (Figure 2-8):
   - **To load transmitter data for the first time** – tap **Download** to retrieve calibration data from the connected transmitter. The download is complete when the firmware version displays in the *Firmware* column.
   - **To add a \transmitter** – tap **Add** and enter a transmitter serial number or other description.
   - **To delete a transmitter** – select a transmitter and tap **Delete**.
   - **To calibrate the transmitter** – see "Transmitter Adjustment" on page 2-32.

   Once the *Transmitters* tab contains a list of transmitters, each transmitter must be set up on a unique channel. The channel button on the transmitter determines the channel that the transmitter broadcasts on.

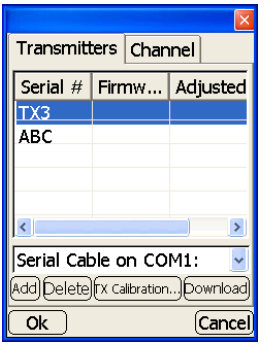


Figure 2-8. Load Transmitters into Pocket-3D

7. To enter transmitter setup information, tap the *Channel* tab and select the connected transmitter, then press **Edit Channel**. Set the following parameters and tap **Ok** (Figure 2-9 on page 2-15):
   - Transmitter – select the ID of the transmitter
   - Control Point – select the control point over which the transmitter is set up
   - TX height – enter the height of the transmitter

- Measured to – select where on the transmitter (Base or Mark/Slant) the height was measured

8. If needed, repeat steps 6 and 7 for up to three other transmitters.
9. Press **OK** when done.

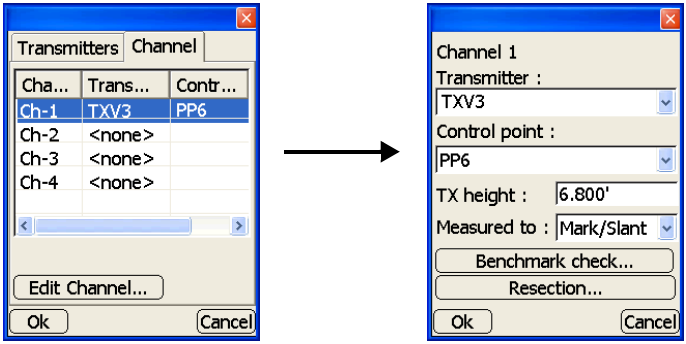


Figure 2-9. Enter Transmitter Channel and Control Point Data

Equipment Setup: GPS

Equipment setup consists of jobsite files to ensure correct data is used for positioning activities and a machine file to ensure the correct measurements are taken.

Step 1: Create a Control Point File

First, create a control point file (Figure 2-10 on page 2-16):

1. Tap **Data** ▸ **Control** ▸ **[<none> or file name]**.
2. Tap **New** to create a control point file.
3. Enter a name for the file and press **Ok**.
4. Select the control point file and press **Ok**.

5. Press **Yes** to apply the file to the jobsite.

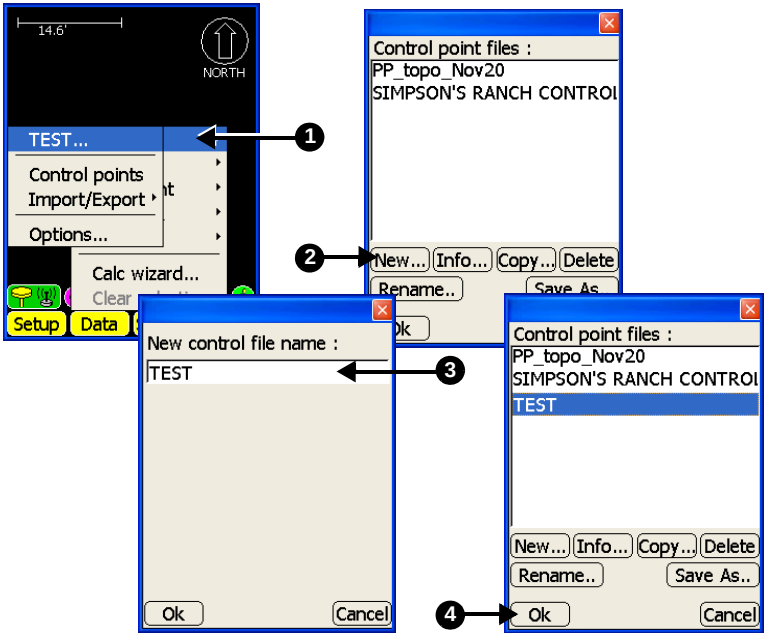


Figure 2-10. Create a Control Point File

Then, enter control point data into the file (Figure 2-11 on page 2-17):

1. Tap **Data** ▸ **Control** ▸ **Control points**.
2. Tap **Add** to enter the local coordinates for the control point.
3. Enter a name and description for the control point and its local coordinates. Press **Ok**.
4. Repeat steps 2 and 3 for each control point.
5. Press **Ok** to save the data.

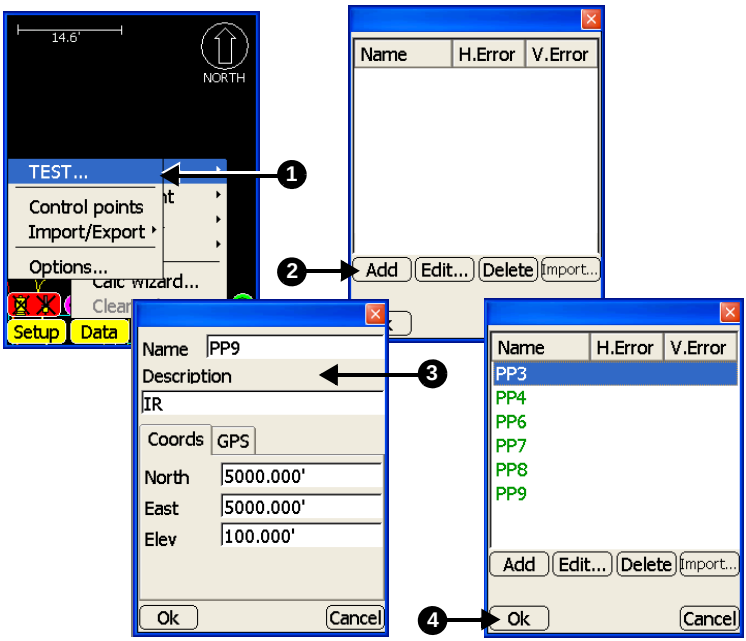


Figure 2-11. Enter Control Points

Step 2: Setup and Initialize a Base Station/Transmitter

For a GPS Base Station, enter antenna and radio information (Figure 2-12 on page 2-18):

1. Connect the controller and receiver. Tap **Setup ▸ Base station**.
2. Select the control point over which the base station is installed and the connection between controller and receiver. Press **Next**.
3. Enter antenna type and height information. Press **Next**.
4. Enter radio type and communication information. If using a Pacific Crest PDL UHF radio, press **Configure** to select channel information and press **Set**. Press **Next**.
5. Select GPS receiver settings. Press **Finish** to initialize the GPS receiver and start the Base.

6. Immediately disconnect the Pocket-3D controller from the receiver. Performing any other activities while connected converts the Base to a Rover.

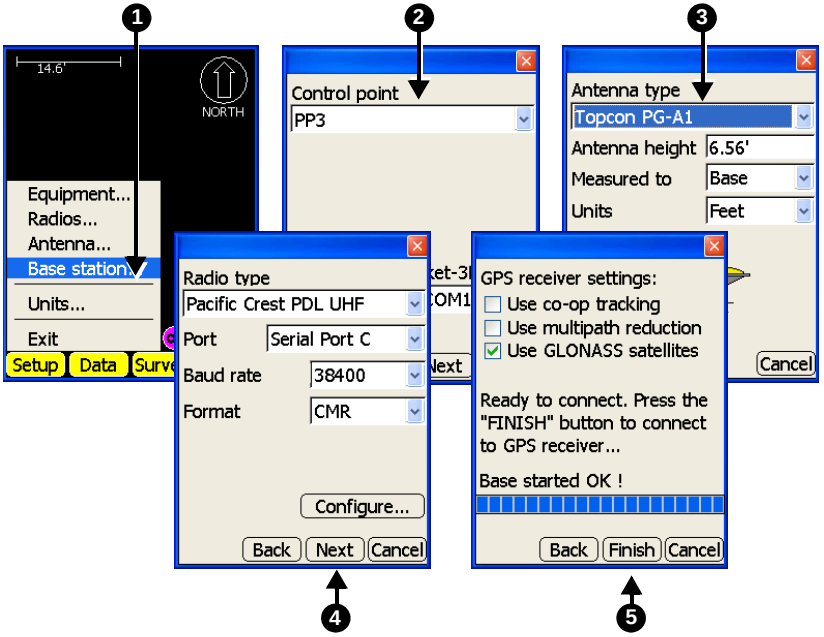


Figure 2-12. Enter Base Station Information and Start Base

For a mmGPS transmitter, enter transmitter information:

1. Connect the controller and transmitter. Check the channel of the transmitter. Tap **Setup ▸ mmGPS transmitters**.
2. Tap the ***Transmitters*** tab and press **Download** to retrieve calibration data from the connected transmitter. Refer to the *Pocket-3D User's Manual* to calibrate or adjust the transmitter (Figure 2-13 on page 2-19).
3. Tap the ***Channel*** tab and press **Edit Channel** to select the channel, the transmitter description, the transmitter ID, and the control point over which the transmitter is installed. Enter the height of the tripod.

4. Press **Ok**. Transmitter information is stored in the control point file; copy this file to the machine for mmGPS grading applications.

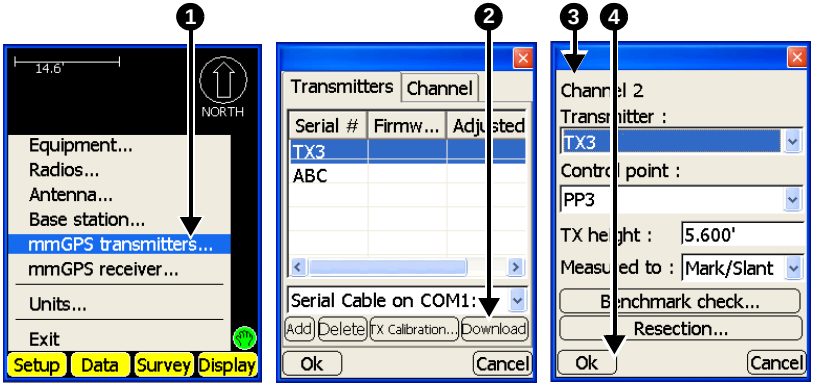


Figure 2-13. Enter Base Transmitter Information

Step 3: Create a Range Pole Equipment Configuration

Pocket-3D creates an equipment configuration for a range-pole Rover (Figure 2-14 and Figure 2-15 on page 2-20). A Rover can be used to check and verify grade.

1. After initializing the Base, connect the Pocket-3D controller to the Rover GPS receiver. Tap **Setup** ▸ **Equipment**.
2. Tap **New**. Enter a configuration name and equipment information. Press **Next**.

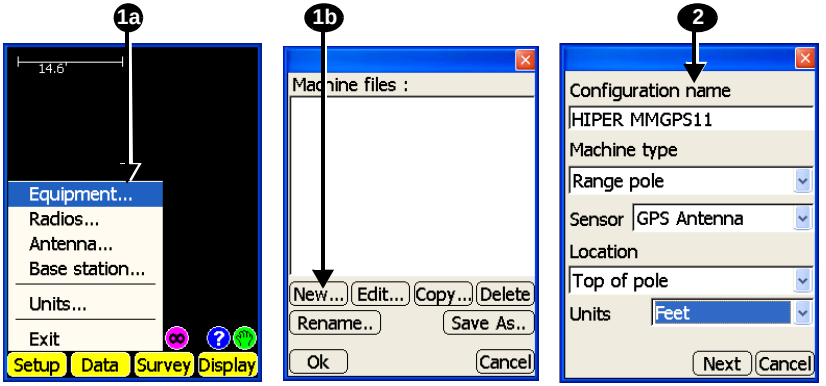


Figure 2-14. Enter Configuration Type

3. Enter antenna information for the range-pole. Press **Next**.
4. Enter radio information. Press **Next**.

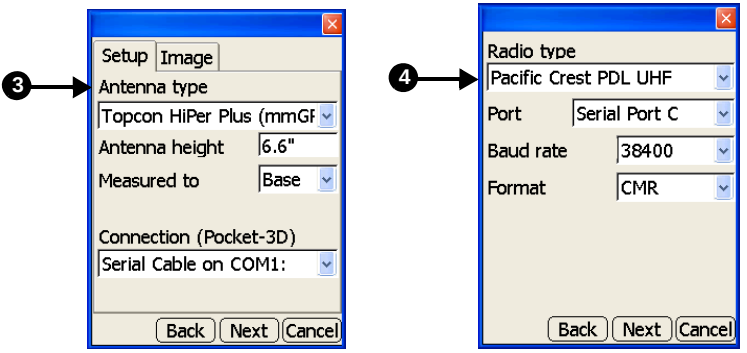


Figure 2-15. Enter Antenna Information and Measurements

5. For a mmGPS Rover (PZS-1 and receiver), enter mmGPS parameters. Refer to the *Pocket-3D User's Manual* for important information about these settings. Press **Next**.
6. Select the configuration and press **Ok**. Press **Yes** (Figure 2-16 on page 2-21).

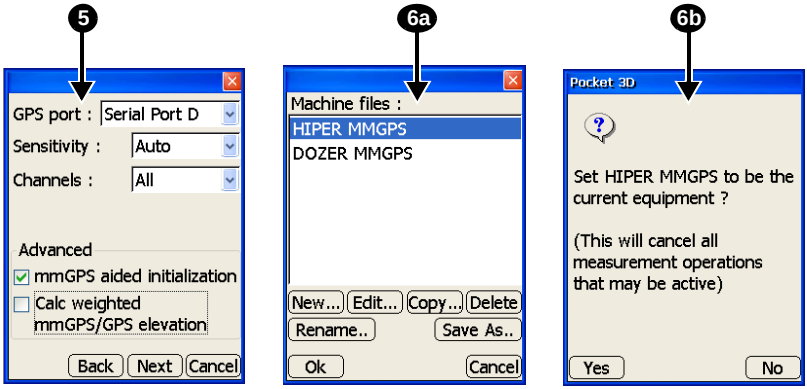


Figure 2-16. Enter Radio (and mmGPS Information); Set As Equipment

Step 4: Setup the Rover Radio

Configuring the range pole Rover radio (Figure 2-17) ensures proper communication with the Base.

1. Tap **Setup ▸ Radios**.
2. Select the radio type and enter its communication settings. If needed, press **Configure** to select the channel.
3. Press **Ok**.

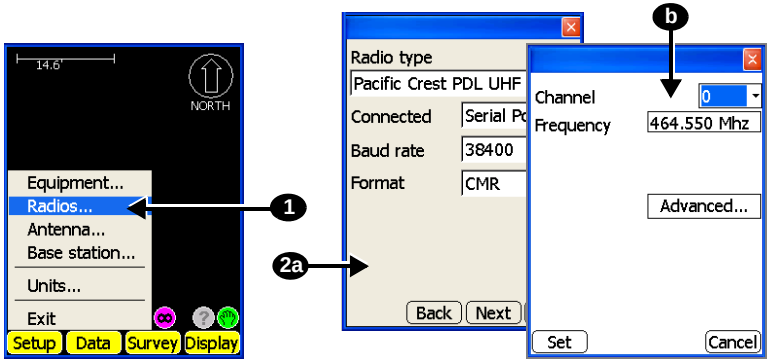


Figure 2-17. Enter Radio Parameters

Step 5: Setup the Rover Antenna

Setup the Rover antenna's type and measurements (Figure 2-18).

1. Tap **Setup ▸ Antenna**.
2. Select the type of antenna and enter its measurement information. Press **Ok**.

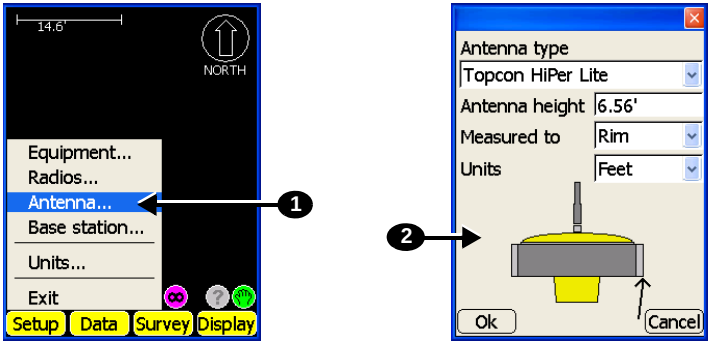


Figure 2-18. Enter Antenna Information for GPS+ (or mmGPS Rover)

Step 6 for mmGPS: Setup the mmGPS Receiver

For mmGPS, setup the mmGPS receiver (Figure 2-19).

1. Tap **Setup ▸ mmGPS receiver**.
2. Enter mmGPS parameters. See Pocket-3D or 3DMC manuals for important information about these settings. Press **Ok**.

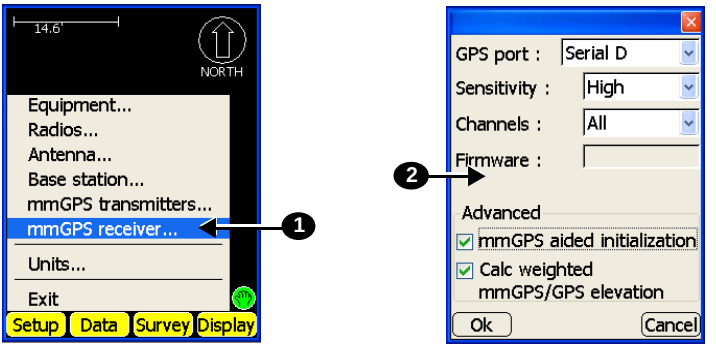


Figure 2-19. Enter mmGPS Information for mmGPS Rover

Step 7: Connect to the Rover

After setting up the rover, connect to the GPS receiver to begin using Pocket-3D at the jobsite (Figure 2-20).

1. On the main screen, tap the **GPS setup** button.
2. Once the connection has been established, press **Ok**.

Notice that the GPS setup button changes color from red to green, indicating successful communication between the Base and Rover.

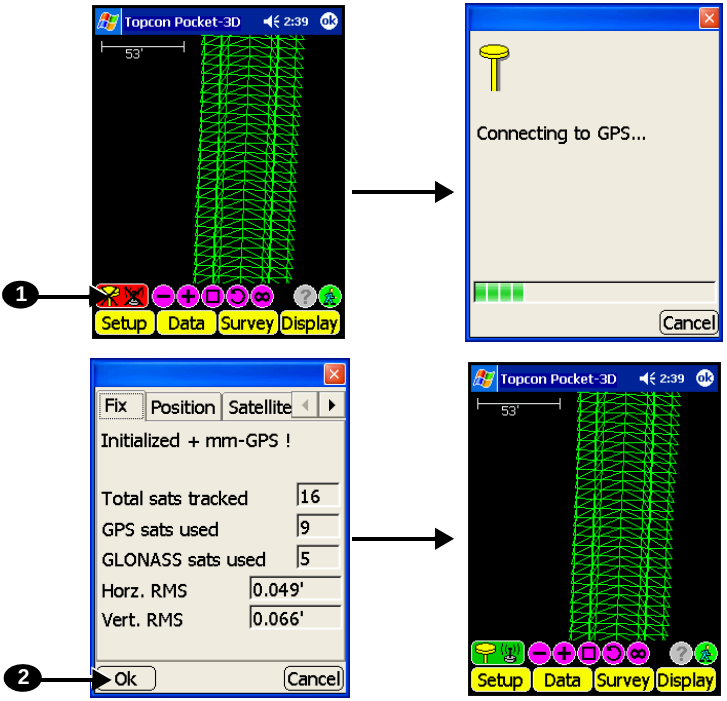


Figure 2-20. Connect to GPS

Localizing with Pocket-3D

After setting up the Base Station, localize the jobsite coordinates with GPS+ coordinates.

1. Ensure the control point file for the jobsite is selected (**Data ▸ Control**) and select the equipment configuration for the current setup (**Setup ▸ Equipment**) (Figure 2-21).
2. Tap **Data ▸ Control ▸ Control points**. Select the point to edit and press **Edit**.
3. Check the local coordinates and press the **GPS** tab.

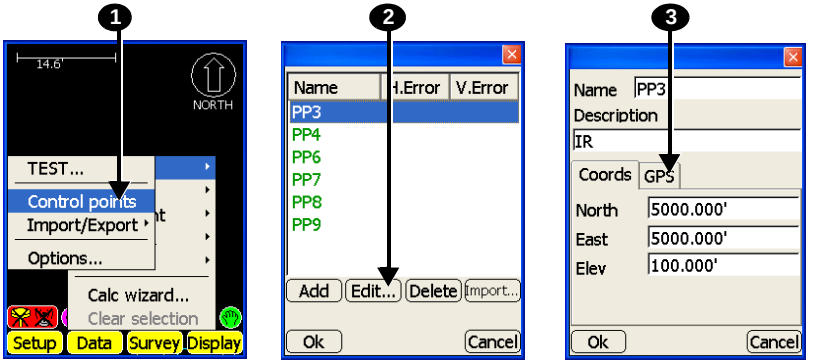


Figure 2-21. Select Control Point to Localize

4. Enable "Use horizontal" and "Use Vertical" and press **Measure**. Press **Ok** to save the measurement (Figure 2-22).

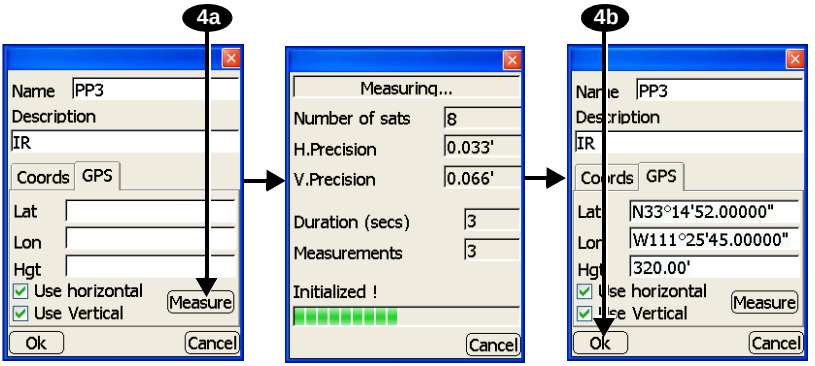


Figure 2-22. Measure Control Point

5. Repeat steps 2, 3, and 4 for each control point.
6. View the results and press **Ok** to save the control point file (Figure 2-23).

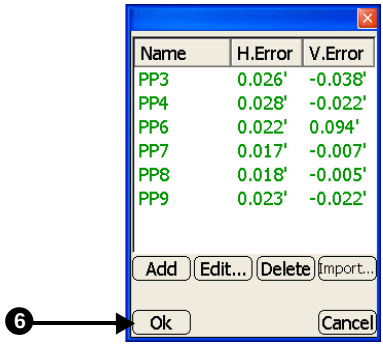


Figure 2-23. Localized Control Points

Creating Files in Pocket-3D

In preparation for collecting point and polyline data, create a points file and a linework file for the jobsite.

Creating a Points File

1. Tap **Data** ▸ **Points** ▸ **[<none> or file name]**. Press **New**.
2. Enter a name for the points file and press **Ok**.
3. Press **Layers** (Figure 2-24 on page 2-26).

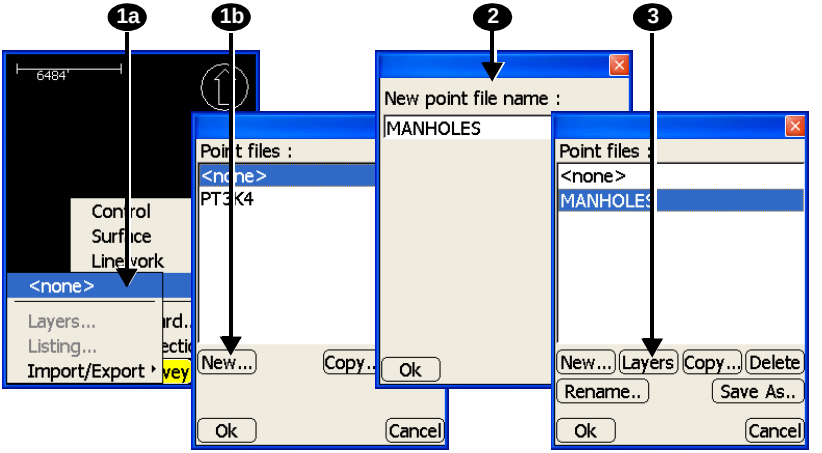


Figure 2-24. Create Points File

4. Press **New**. Enter a name for the layer and the layer's parameters. Press **Ok** (Figure 2-25).
5. Repeat step 4 for any other layers.
6. Press **Ok** to save the file. Press **Yes** to apply the file to the current jobsite.

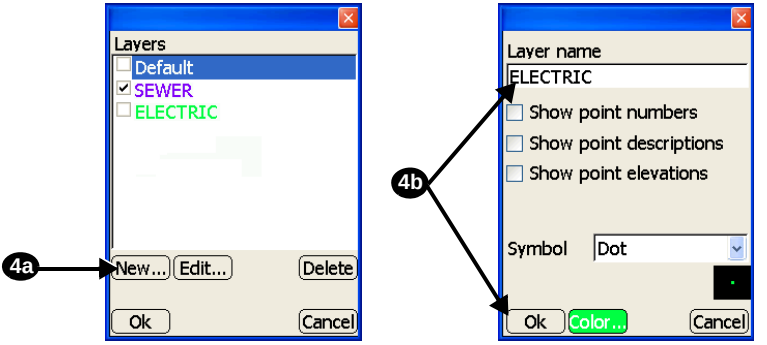


Figure 2-25. Add Layers to Points File

Creating a Linework File

1. Tap **Data** ▸ **Linework** ▸ **[<none> or file name]**. Press **New** (Figure 2-26).
2. Enter a name for the linework file and press **Ok**.
3. Press **Layers**.

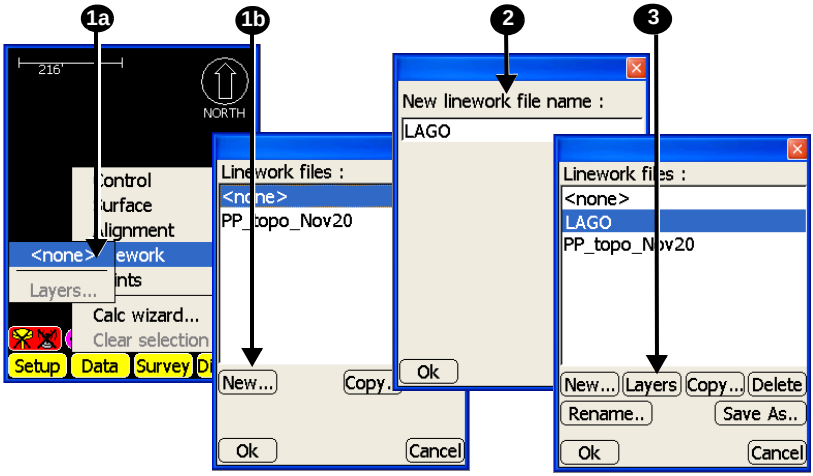


Figure 2-26. Create Linework File

4. Press **New**. Enter a name for the layer and the layer's parameters. Press **Ok** (Figure 2-27).
5. Repeat step 4 for any other layers.
6. Press **Ok** to save the file. Press **Yes** to apply the file to the current jobsite.

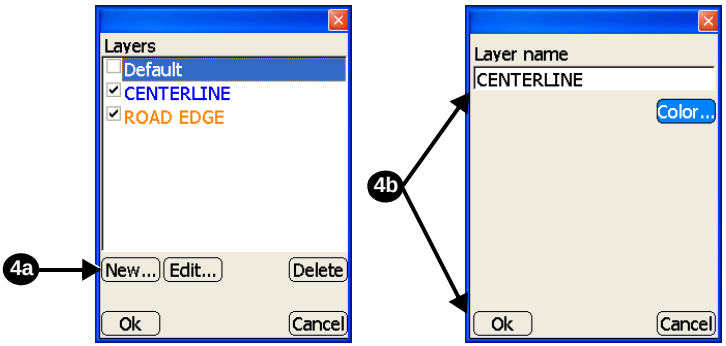


Figure 2-27. Add Layers to Linework File

For information on collecting points, creating polylines, or measuring a control point, refer to the *Pocket-3D Reference Manual* or the *Pocket-3D User's Manual*

mmGPS Operations with Pocket-3D

Pocket-3D software, although optional, is required for some operations. Pocket-3D runs on a hand-held controller, such as Topcon's FC-100.

Performing a Resection

The resection function measures an unknown transmitter location using the rover and three or more points. In general, the results from a resection are adequate for horizontal positioning of the transmitter (an error estimate also displays). Performing a height check and adjustment fine-tunes the calculated elevation.

When performing a resection, use the following guidelines to ensure accurate measurements at the Rover points:

- take measurements at three or more points around the Base transmitter in a balanced, symmetrical pattern (not clustered in one area)
- have the sensor facing towards the transmitter during each measurement
- angle the sensor between 6° higher or lower than the transmitter's beam, not straight on

1. Set up the transmitter at an unknown location. Power on the transmitter and select a channel to transmit on.
2. Set up the PZS-1 sensor. Power on the sensor and receiver. Connect the sensor and Pocket-3D controller.

Use a bi-pole to ensure the sensor remains steady throughout the calibration process.

3. Walk several feet away from the transmitter and face the sensor towards the transmitter (Figure 2-28).

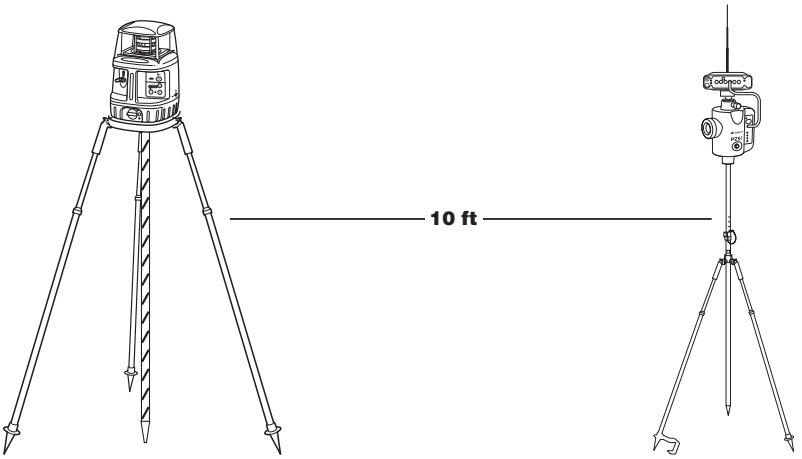


Figure 2-28. Setup Transmitter and Sensor

4. In Pocket-3D, tap **Setup ▸ mmGPS transmitters**.
5. On the *Channel* tab, press **Edit Channel**.
6. Tap the **Resection** button on the ***channel setup*** dialog box (Figure 2-29 on page 2-30).
7. Optionally, enter the following measurement parameters on the ***resection*** dialog box (Figure 2-29 on page 2-30).
   - Duration (secs) – enter the duration, in seconds, in which to measure the point.
   - H. Precision / V. Precision – enter a horizontal / vertical precision, in the project's units, with which to measure the point.

   The point name is automatically added to the list of control points as "TX-[n] (Resected)", where "n" is the channel number.

Subsequent resections with the same transmitter overwrites any previous points.

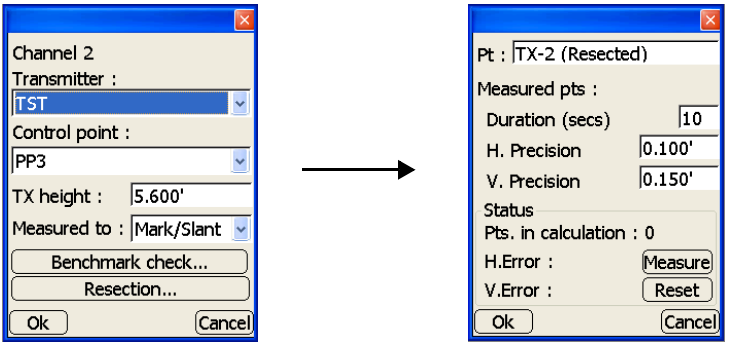


Figure 2-29. Begin Resection

8. Press **Measure**. The ***Measuring*** dialog box displays during the measurement. When done, the *Pts. in calculation* field increments by one.
9. Move to the next point and repeats step 7 and 8. Continue until at least three points, evenly located around the transmitter, have been measured.

   To clear the measurements and begin again, press **Reset**.

   After three points have been successfully measured, horizontal and vertical errors for the measured point displays. Further measurements should improve the positional error.
10. Press **OK** when done.

Checking the Transmitter's Height

1. Set up the transmitter and tripod at a known control point. Power on the transmitter and select a channel to transmit on.
2. Set up the PZS-1 sensor over a known point. Power on the sensor and receiver. Connect the sensor and Pocket-3D controller.

Use a bi-pole to ensure the sensor remains steady throughout the calibration process.

3. In Pocket-3D, tap **Setup ▸ mmGPS transmitters**.

4. On the *Channel* tab, press **Edit Channel**.
5. Press **Benchmark check** (Figure 2-30).
6. On the ***transmitter height*** dialog box, select one of the following and press **Start** to measure (Figure 2-30). During the measurement, the ***Measuring*** dialog box displays.
   - If the transmitter is set up over a known control point, tap the first radio button then select the control point from the drop-down list.
   - If the transmitter is set up over a point with a known elevation tap the second radio button, then enter the elevation.

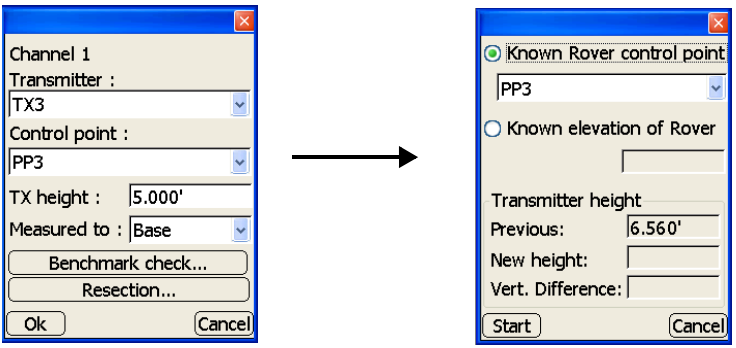


Figure 2-30. Begin Height Check

7. Press **Ok**. The *Transmitter height* fields displays the calculated difference between the height originally specified for the transmitter and the calculated height (Figure 2-31).

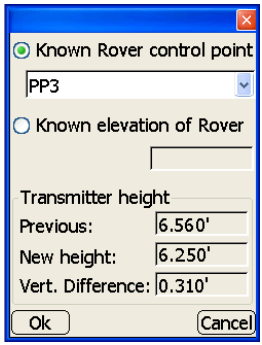


Figure 2-31. Measure Height of Transmitter

8. To apply this change to the transmitter setup, press **Ok**. Or press **Cancel** to exit without saving the measurement.

Transmitter Adjustment

The adjustment function fixes errors in incline in the self-leveling mechanism of the transmitter, applying an offset to the transmitter.

1. Set up the transmitter and tripod at an known control point.
2. At the transmitter, hold the **plumb beam key**, then press and release the **power key** to put the transmitter into calibration mode.
3. Turn the front of the transmitter towards the sensor.
4. Set up the PZS-1 sensor at the same level as the transmitter, on relatively level ground, and approximately 50 meters (100 feet) away. Power on the sensor and receiver (Figure 2-32). Connect the sensor and Pocket-3D controller.

Use a bi-pole to ensure the sensor remains steady throughout the calibration process.

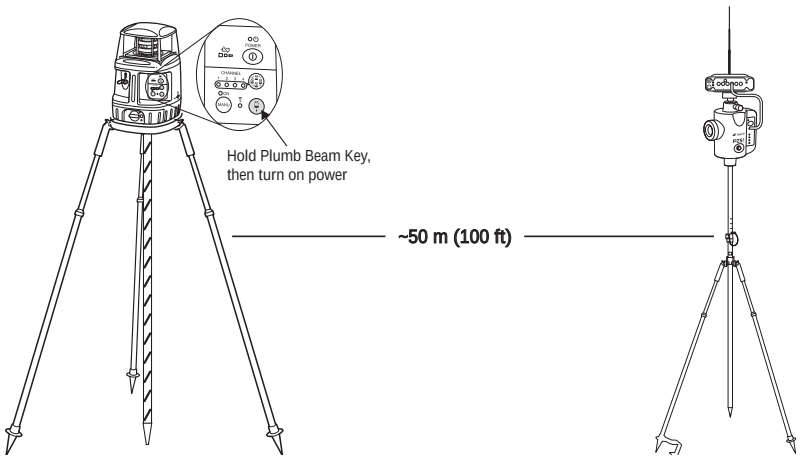


Figure 2-32. Setup Transmitter and Sensor

5. In Pocket-3D, tap **Setup ▸ mmGPS transmitters** and press **TX Calibration** (Figure 2-33).

   If indicated, check the setup listed on-screen (Figure 2-33).

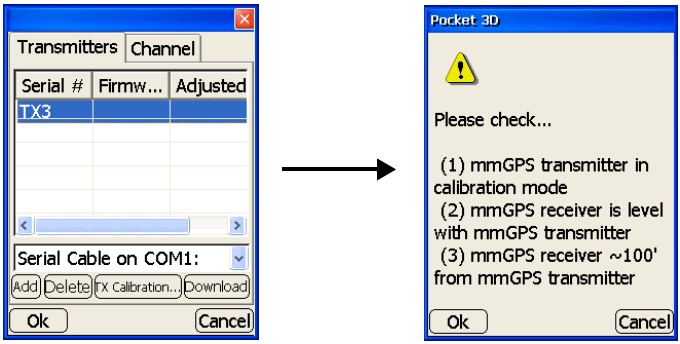


Figure 2-33. Begin Field Calibration Adjustment

6. If needed, adjust the height of the sensor so the angle is less than 1°. Once the angle is okay, tap **Next** (Figure 2-34).
7. Press **Next** to begin the first phase of the adjustment (Figure 2-34).

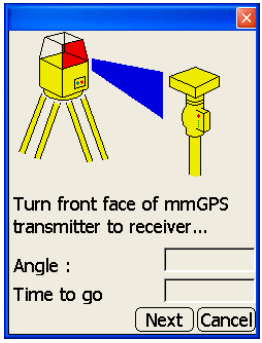


Figure 2-34. Begin Adjustment

NOTICE

If the sensor experiences excessive movement during any stage of the adjustment, an error message displays. Press Cancel and stabilize the Rover pole. Then press Adjust again.

8. Follow the on-screen instructions, pressing **Next** to measure (Figure 2-35). If indicated, check the setup listed on-screen.

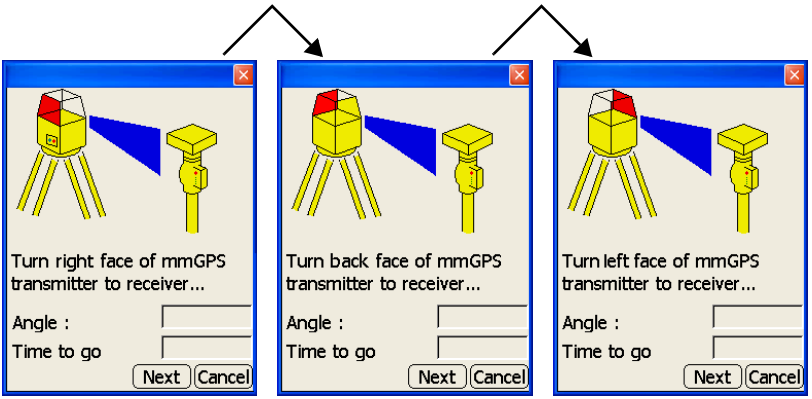


Figure 2-35. Transmitter Adjustment Process

When the adjustment completes, the ***Adjustment*** dialog box displays the offsets (Figure 2-36 on page 2-35).

- If both *Axis* measurements are less than 10", no adjustment is needed at the transmitter.
- If either or both *Axis* measurements are more than 10", disconnect from the sensor and connect to the transmitter. Press **Finish** to upload the adjustments to the transmitter. When finished uploading, the transmitter applies the adjustments and turn off.

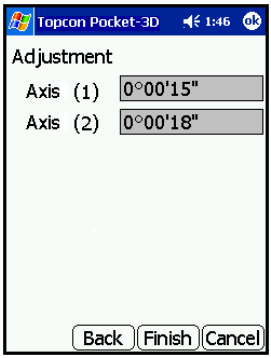


Figure 2-36. Adjustment Results

After loading the new self-leveling offset data into the transmitter, re-calibrate to check the system. The transmitter may need to be calibrated a couple of times depending on site conditions.

Note that this process only applies an offset to the self-leveling mechanism to ensure correct grade, the control point file is not affected.

Notes:

Setting up the Machine and 3DMC

The components of the mmGPS 3D Paver provide real-time elevation and slope information to the 9168 control box. The control box then takes this information and applies various algorithms to calculate and display accurate, current surface information. This chapter introduces the various features and general functions of components that the operator uses, including the following:

- The features of the 9168 control box and how they operate.
- The functions of the 3DMC software and how to use it.

When operating in rainy weather or in wet conditions, the system's components (control box, transmitter, receiver, tracker) and cables must be thoroughly dried BEFORE placing them in the carrying case at the end of the day.

Any moisture in the carrying case causes condensation on the inside of the components which may severely affect accurate operation during the next paving application.

9168 Control Box Buttons and Features

The control box is the operator's interface to mmGPS 3D Paver, receiving signals from the sensors, and using these signals to determine if grade or slope corrections are necessary. If the machine requires a change in elevation or slope, the control box sends a signal to the valve controlling the tow point cylinder on the appropriate side of the paver to raise or lower, thus maintaining correct mat thickness. In 2D control, the operator can control and monitor the slope and thickness of the mat using the knobs and displays located on the front panel of the 9168 control box.

Front Panel

The control box front panel (Figure 3-1) displays information about grade, displays the 3DMC software, and makes quick changes to offsets and other settings.

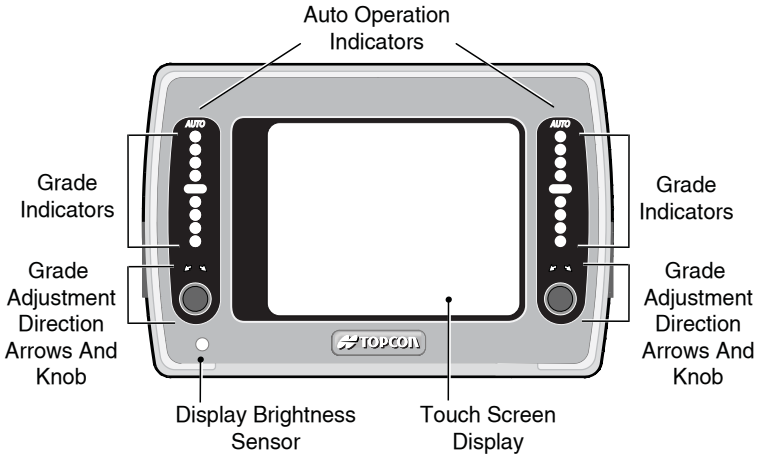


Figure 3-1. Control Box – Front Panel

Automatic Operation Indicators The automatic operation indicators, the "AUTO" LEDs located above the grade indicators, illuminate when activating one or both Auto/Manual switches for

automatic grade control. The AUTO LEDs are independent of each other.

Grade Indicators The grade indicators visually translate, in real time, the distance of the screed to on-grade. Table 3-1 describes the visual patterns to on-grade.

Table 3-1. Grade Indicators

LED Action	Elevation Indicator	Slope Indicator
Slow Blinking Yellow	Out of range GPS+ over .4 ft above grade 2D over .2 ft above grade	Out of range Over 2% above grade
Triple Solid Yellow	Above grade GPS+ between .05 and .4 ft 2D between .05 and .2 ft	Above grade Between 1% and 2%
Double Solid Yellow	Above grade Between .03 and .05 ft	Above grade Between .5% and 1%
Single Solid Yellow	Above grade Within .03 ft	Above grade Within .5%
Blinking Green Bar	On grade Within deadband	On grade Within deadband
Single Solid Red	Below grade Within .03 ft	Below grade Within .5%
Double Solid Red	Below grade Between .03 and .05 ft	Below grade Between .5% and 1%
Triple Solid Red	Below grade GPS+ between .05 and .4 ft 2D between .05 and .2 ft	Below grade Between 1% and 2%
Slow Blinking Red	Out of range GPS+ over .4 ft below grade 2D over .2 ft below grade	Out of range Over 2% below grade

Grade Adjustment Knobs The grade adjustment knobs make measured adjustments to the cross-slope or elevation settings. Table 3-2 describes knob operation for the different control modes.

Table 3-2. Grade Adjustment Knob Operation

Control Mode	Grade Adjustment Knob Usage
mmGPS	The knob assigned to elevation control applies an offset to the Design Surface (that is, elevation setting). • Turn the knob clockwise to apply less material, lowering the screed. • Turn the knob counterclockwise to apply more material, raising the screed. The knob assigned to slope control is disabled during paving operation (except while making changes in a menu function).
2D	The knob assigned to elevation control applies an adjustment to the set point (that is, elevation setting). • Turn the knob clockwise to apply less material, lowering the screed. • Turn the knob counterclockwise to apply more material, raising the screed. The knob assigned to slope control adjusts the percentage of slope in the direction of the knob's rotation. • Turn the knob clockwise to tilt the screed to the right. • Turn the knob counterclockwise to tilt the screed to the left.

Grade Adjustment Direction Arrows The grade adjustment direction arrows (Figure 3-2) illuminate red, indicating the direction of knob rotation to reach on-grade. They also illuminate to indicate that you can use the grade adjustment knobs to change values while in adjustment and calibration modes.

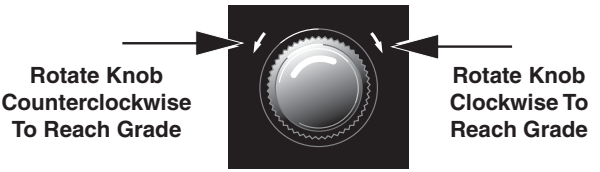


Figure 3-2. Grade Adjustment Arrows

Brightness Sensor Window This window allows an internal optical sensor to measure ambient light, providing automatic adjustment of the display's backlight.

Blocking the brightness sensor may cause incorrect adjustments of the display's brightness level.

Touch Screen Display The touch screen display provides textual information, graphic symbols and graphic mappings, all of which the operator can use to prepare a job, to apply changes on screens and functions, and to perform machine paving. For every operation, simply tap the screen with a finger to make selections or enter information.

The screen's backlight varies automatically, depending on ambient light, so the operator can always view the screen's information under optimum brightness.

The surface of the touch screen display has a durable coating, but avoid contact with any metal or abrasive object. Prevent any hardware from contacting the touch screen display. Do not rub or force dust from the surface.

Back and Side Panels

The 9168 control box back and side panels (Figure 3-3) include a compact flash card slot, cable connectors for communication, a cooling fan, a speaker, and the power switch.

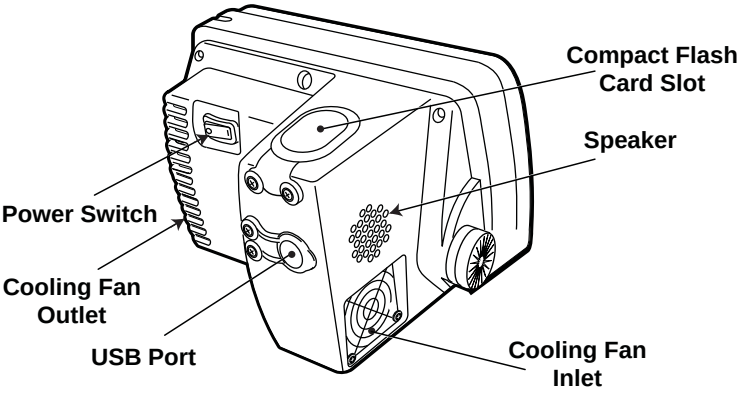


Figure 3-3. 9168 Control Box – Back and Side Panel

Compact Flash Card Slot The compact flash card slot allows you to transfer files to/from the control box to a computer via a compact flash card. The internal interface driver is compatible with commercially available compact flash cards. A rubber flap seals the compact flash card slot, preventing dust, water, and so forth from entry.

Keep the rubber flap closed at all times, even during use, to prevent dust from entering the slot.

When copying files to or deleting files from a compact flash card, the control box screen displays an hourglass, indicating the system is busy. Once the hourglass goes away, you can remove the compact flash card.

Occasionally, the control box may not properly detect the compact flash card during a hot-swap procedure. If this occurs, simply turn off and restart the control box.

The card can be damaged if you remove it before completing the copying/deleting process.

Speaker The control box produces sounds through the speaker to indicate certain activities, such as selecting a menu option or changing a selection, on the 3DMC main screen.

Cooling Fan Inlet and Outlet The control box has an efficient cooling system to keep it from overheating. When powered on, the cooling fan rotates, bringing air in through the cooling fan inlet. The air then circulates through the control box, cooling down components, and out the cooling fan outlet. Air within the enclosure constantly circulates, automatically cooling the internal heat sink plate.

Do not place objects that can obstruct air circulation near the inlet and outlet.

USB Port The USB port allows you to transfer files to/from a control box and to connect with a commercial keyboard or mouse. You can use a keyboard or mouse in the same way you use the touch screen: to navigate through menus and enter information. A rubber flap seals the USB port, preventing dust, water, and so forth, from entry.

Keep the rubber flap closed while not in use to prevent dust from entering the port.

Power Switch The power switch (Figure 3-4) turns on the control box, as well as the sensors installed on the machine. After a few moments, the 3DMC software appears on the touch screen display and is ready to use.

Figure 3-4. Power Switch

The control box saves and stores previous settings, elevation offsets, and the cross-slope calibration. Upon power-up, the 9168 control box applies these settings, offsets, and calibrations. Except for variable day-to-day measurements of the receiver and the screed, you can use saved calibrations and adjustments for several weeks or months.

Connectors

The connectors (Figure 3-5) supply power to the mmGPS 3D Paver machine and link system sensors and components installed on the machine with the 9168 control box.

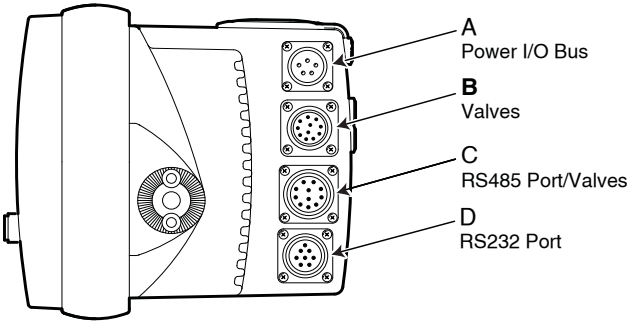


Figure 3-5. 9168 Control Box – Connectors

Depending on your control application, the connectors used during operation varies.

3DMC

3DMC is the software interface between the operator and the machine's components. The menus and keys allow files to be created, updated, superimposed, copied, or deleted. Information and files the operator can access are stored and continuously updated to the internal memory.

The main screen (Figure 3-6) displays a graphical view of the current design surface, the machine, and status information of connected components.

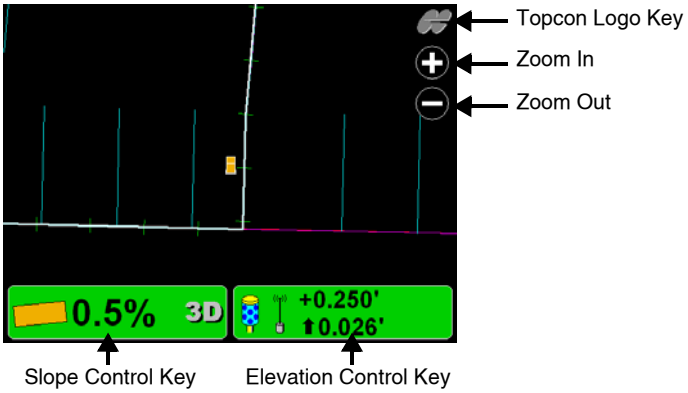


Figure 3-6. Main Screen

The main screen has the following components:

- **Display** – a graphical representation of the design surface and the machine. The display varies according to the type of design surface file and selected display options. Views include a superimposed triangle mesh, contour lines, alignment lines and points, a partial blade cross section view, and a machine profile view.

  The sections in "Display Options" on page 3-71 starting describe the different displays available to view jobsite information and grade information. Units can be in feet or metric.

  Tapping anywhere on the display screen brings up a pop-up menu (see "File Menu" on page 3-14 for details).

- **Topcon Logo Key** – provides access to menus that control a variety of functions. See “Topcon Logo Key” on page 3-12 for more information on the key and its menus.
- **Zoom In Key** – increases the magnification of the design view each time you tap this key. The zooming pivot is the center of the screen.
- **Zoom Out Key** – decreases the magnification of the design view each time you tap this key. The zooming pivot is the center of the screen.
- **Elevation Control Key** – displays elevation control information and indicates the status of the connected sensor. Tap this key to view or edit elevation information. See “Elevation Control Key” on page 3-76 for more information on this key and its menu.
- **Slope Control Key** – displays cross-slope control information and indicates the status of the connected sensor. Tap this key to view or edit slope information. See “Slope Control Key” on page 3-88 for more information on this key and its menu.

Using 3DMC

The various dialog boxes throughout 3DMC have buttons to perform operations, such as creating, updating, copying, or deleting files (Figure 3-7 on page 3-11). Any and all information the operator can access is stored and continuously updated to either the internal memory or a compact flash card.

- **New** – Creates a new file or element.
- **Edit** – Changes an existing file or element. To edit a file, select a file or element, then press the **Edit** key.
- **Copy** – Copies a file either from the compact flash card to the internal memory or from the internal memory to the compact flash card. To copy a file, select the file, then press the **Copy** key. Copy new or edited files to the compact flash card to back up the file.

- **Delete** – Removes an existing file or element from the internal memory. To delete a file or select it and press the **Delete** key.

NOTICE

Once you delete a file, it no longer exists. The file must be created from the beginning.

- **Next** – Displays the next step or dialog box during an operation after all applicable settings have been entered.
- **Back** – Displays the previous step or dialog box during an operation.
- **Ok** – Applies settings and inputs and exits the dialog box and/or operation, or used to change files or apply settings in sub-screens.
- **Cancel** – Cancels or pauses an operation without applying changes or edits.

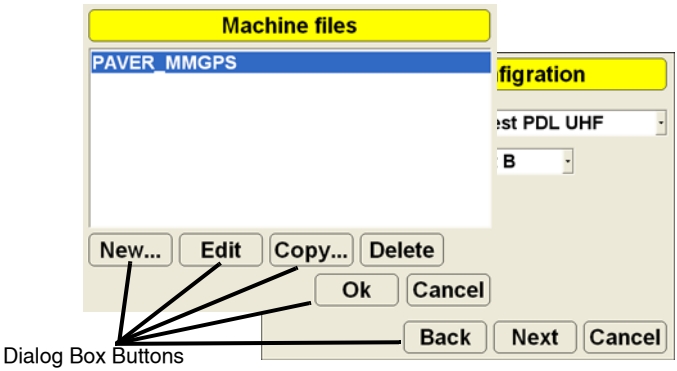


Figure 3-7. Example Dialog Box Buttons

When entering text or numbers, one of the following two pop-up keyboards display (Figure 3-8 on page 3-12):

- Alphanumeric keyboard – for entering letters and numbers.
- Numeric keyboard – for entering numbers.

File and point names can be up to 32 characters long; point descriptions up to 64 characters long.

When you press **Ok** on the keyboard, entered information becomes valid and the keyboard leaves the screen.

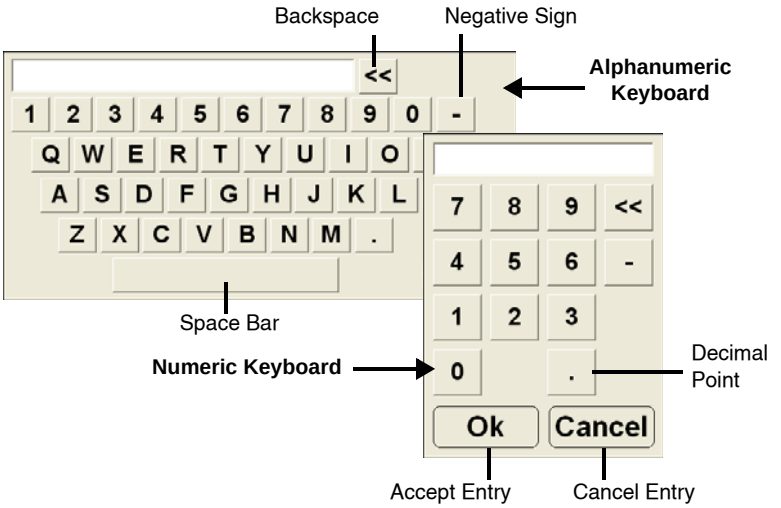


Figure 3-8. Keyboards

Topcon Logo Key

The Topcon Logo key at the top right corner of the Main Screen displays a pop-up bar of four menus: File, Control, Tools, and View.

To access the Topcon Logo menus, tap the **Topcon Logo** in the far right corner. The four menus display (Figure 3-9).

Unless used, the menus disappear after 10 seconds.

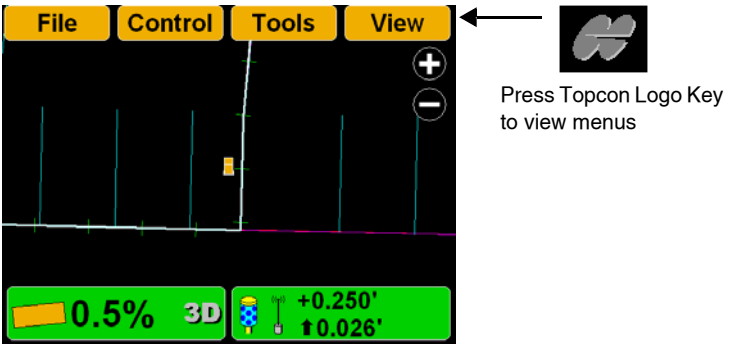


Figure 3-9. Topcon Logo Menus

Table 3-3 describes the functions available under each menu.

Table 3-3. 3DMC Menus Description

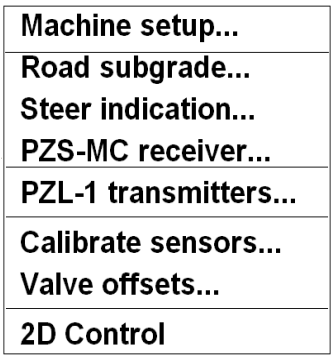
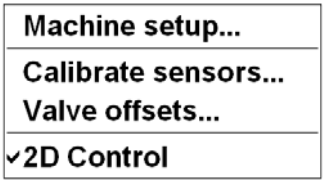
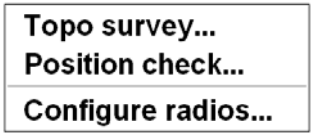
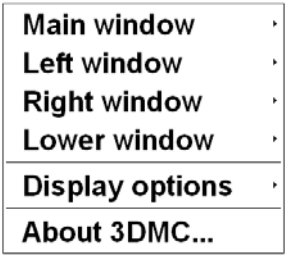
Menu	Available Functions
File menu 	• creating, editing, and deleting control point files • creating, editing, and selecting working and reference (design) surface files • selecting alignment files • selecting linework files • creating, editing, and deleting point files • exiting 3DMC
Control menu, mmGPS applications 	• creating, editing, copying, and deleting machine setup files • if a road file is selected as the reference surface, setting road subgrade properties • selecting the steering indication • configuring the PZS-MC receiver • configuring up to four PZL-1 laser transmitters • calibrating the slope sensor • applying valve offsets • enabling 2D control
Control menu, 2D applications 	• creating, editing, copying, and deleting machine setup files • calibrating the slope sensor • applying valve offsets • disabling 2D control
Tools menu 	• collecting topographic points • checking the position • configuring the radio The Tools menu is not active for 2D applications.

Table 3-3. 3DMC Menus Description (Continued)

Menu	Available Functions
View menu 	• displaying Plan, Section, and Profile views in the Main Window • viewing a left window that displays the Profile, Section, or Grade indicator • viewing a right window that displays the Grade Indicator. • viewing a lower window that displays the Profile, Section, Light bar, or Cut/fill history (for mmGPS applications) • viewing and selecting display options for various data; menu options depend on the files selected for display • viewing 3DMC information, authorization codes, and options

File Menu

Before beginning to work with the mmGPS 3D Paver, you must have job files that contain various information needed to accurately grade the jobsite. The job files you need include control point files, design surface files, and machine configuration files. This chapter discusses how to create and access these files.

Control Point Files

The first task, when setting up the mmGPS 3D Paver on a new jobsite, is to create a new Control Point file. You can use either the machine to create a control point file, or copy a control point file from a Pocket-3D controller. For more information on Pocket-3D, see “Hand-held Controller and Pocket-3D” on page 2-1.

The Control Point file consists of descriptions, local site coordinates, global GPS coordinates, and units of measurements for each Control Point located on the site. Typically, the project’s survey team provides Control Point information after accurately measuring these points with a surveying instrument.

Selecting a Control Point File

1. When the 3DMC main screen displays, press **Topcon Logo** ▸ **File** ▸ **Control**.
2. Select the control point file for the jobsite and press **Ok** (Figure 3-10).

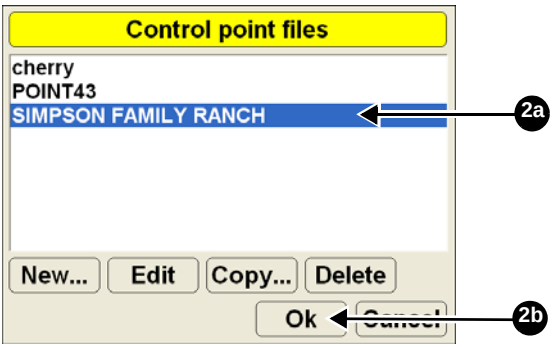


Figure 3-10. Applying a Control Point File

Creating a Control Point File

This section describes how to create the Control Point file using existing control point information. The control point file created here may be tentative, but provides a beginning from which to create a more thorough file later.

When creating a control point file, neither the MC-2.5 Receiver Box nor any sensors need to be attached or ready to use at this stage.

NOTICE

The accuracy of measurements for local site coordinates of a control point directly affects the quality of grade.

1. Turn on the control box.
2. When the 3DMC main screen displays, press **Topcon Logo** ▸ **File** ▸ **Control**.
3. Press **New** and enter a name for the control point file, press **Ok**, on the keyboard, then press **OK** again (Figure 3-11 on page 3-16).

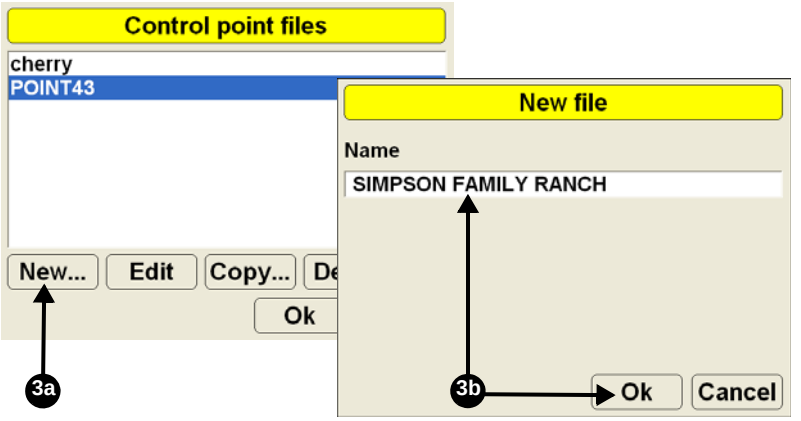


Figure 3-11. Press Copy and Select Location of Files

4. Select the newly created file and press **Edit**. Then press **Add** (Figure 3-12).

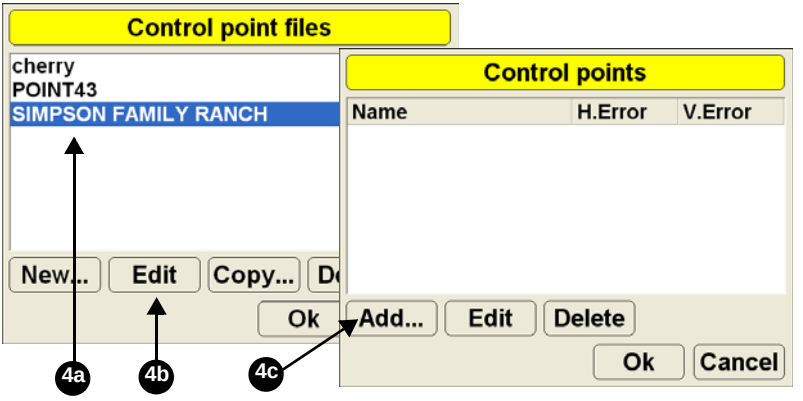


Figure 3-12. Edit Selected File

5. Enter the following information for the control point (Figure 3-13 on page 3-17):
   - Name – enter a unique name
   - Site coords – enter the coordinates for northing (N), easting (E) and elevation (Z)

- WGS84 – if you have precise GPS coordinates, enter the coordinates for latitude (Lat), longitude (Lon) and height (Hgt)
- Localization check boxes – only enable these if currently performing a GPS localization

6. Press **Ok** to save this control point.

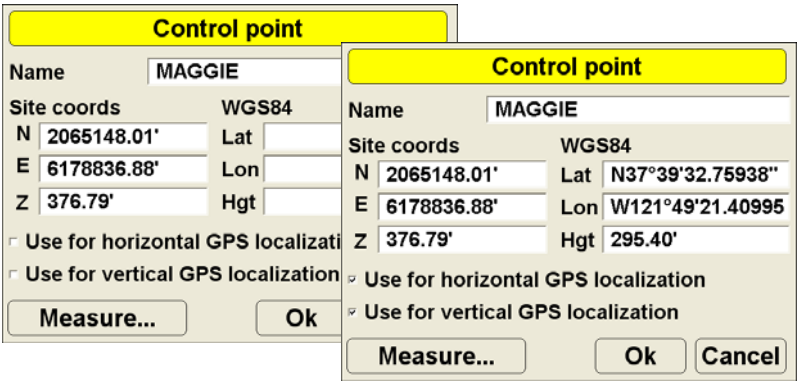


Figure 3-13. Control Point Coordinates Without and With GPS Localization

7. Press **Add** on the ***Control points*** dialog box and repeat steps 5 and 6 above for all control points.
8. After adding all control points (Figure 3-14 on page 3-18), press **OK** to save the control points file.

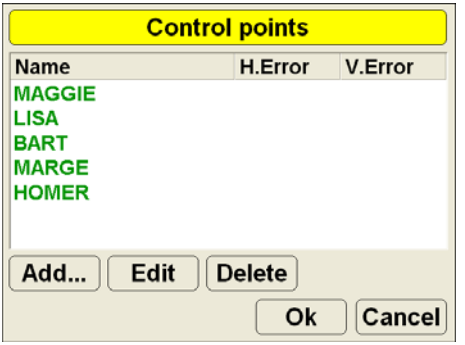


Figure 3-14. Save Control File After Adding Control Points

NOTICE

Data entry errors have a direct affect on paving accuracy.

NOTICE

You must press Ok to save the file. Failure to do so results in losing all information and require you to repeat the process.

GPS Localization

After you have setup all the hardware components and initialized the Base Station, you need to localize the GPS coordinates to the jobsite's coordinates. This section gives information on the principles of GPS localization and entering GPS localization, into the Control Box.

Principles of GPS Localization

The GPS+ system is capable of precise positioning, but the positions it computes are relative to a global reference system defined in terms of a geographic latitude, longitude and height above (a representation of) the earth's surface.

To be useful for local site work, global GPS coordinates need to be converted into local site coordinates, defined in terms of a distance north and east of some origin point and some distance above an elevation datum. These north, east, and elevation coordinates (often abbreviated to NEZ coordinates) may be those of a regional coordinates system—for example, a state plane system in the United States—or the project's survey crew may arbitrarily define these coordinates for the specific site; NEZ coordinates must be defined in terms of the construction design data. In either case, a mathematical conversion is necessary to turn global GPS coordinates into NEZ coordinates relative to a locally defined coordinate system.

The basic approach to calculating the mathematical conversion is to provide pairs of point coordinates for each Control Point on the project. A point pair consists of the following coordinates:

- (a) local NEZ coordinates for the point (obtained from the project's survey crew).
- (b) global latitude, longitude, and height coordinates for the point (measured as described in this section or obtained from the project's survey crew).

These pairs of points are needed to calculate a precise mathematical conversion formula for converting all global GPS coordinates generated in the MC-2.5 Receiver Box to local NEZ coordinates for a particular project.

The following steps help to ensure a high-quality localization suitable for centimeter-level machine paving with mmGPS 3D Paver.

- First, the surveyor's local Control Points must be precisely measured. The quality of measurements directly affects paving accuracy.
- Second, the Control Points need to be located more or less evenly around the site. Generally, the more Control Points the better, but if they are clustered together or are all at one section of the site, then the results are less than ideal.

  Locate Control Points evenly distributed around a perimeter of the site or paving area. While not directly related to the quality of localization, locate Control Points that are elevated, easily accessible, and not obstructed by trees, buildings, other structures, moving vehicles, and so forth.
- Third, GPS localization requires a minimum of three Control Points, but at least four or more points should be used for the localization.

GPS localization is processed in the control point file created prior to beginning each project. This control point file contains the formula necessary for the mathematical conversion between global GPS coordinates and NEZ coordinates. A control point file can be localized using one of the following methods:

- Measuring each control point with a Topcon GPS+ or GPS RTK Survey Rover System and Pocket-3D. Then entering this information into 3DMC.

  See "Localizing with Pocket-3D" on page 2-24 for this procedure.
- Entering global GPS coordinates directly into 3DMC.

  See "Entering Localized GPS Coordinates" on page 3-21 below for this procedure.

Entering Localized GPS Coordinates

GPS localization is processed in the control point file created prior to beginning each project. This control point file contains the formula necessary for the mathematical conversion between global GPS coordinates and NEZ coordinates. The control point file can be localized by entering global GPS coordinates directly into the 9168 control box. One of the following sources can measure points and provide coordinates:

- Each control point is measured with a Topcon GPS+ or GPS RTK Survey Rover System and Pocket-3D.
- A third party source provides GPS coordinates.

If the control point file in 3DMC needs to be updated with localized coordinates, the operator can enter global GPS coordinates directly into the 9168 control box. The control box then processes the localization as the operator sits in the cab.

Because this method deals with control point files, see “Creating a Control Point File” on page 3-15 for further information.

1. Power on the control box and allow the 3DMC application program start up. Have the measurements for each Control Point available.
2. Press **Topcon Logo ▸ File ▸ Control**. The ***Control point files*** dialog box displays (Figure 3-15 on page 3-22).
3. Select the correct control points file, and press **Edit**. The ***Control points*** dialog box displays, listing all control points for the file and jobsite (Figure 3-15 on page 3-22).

4. Select a control point and press **Edit**, the ***Control points*** dialog box displays. This control point file should already have local site coordinates from the selected control point file (Figure 3-15).

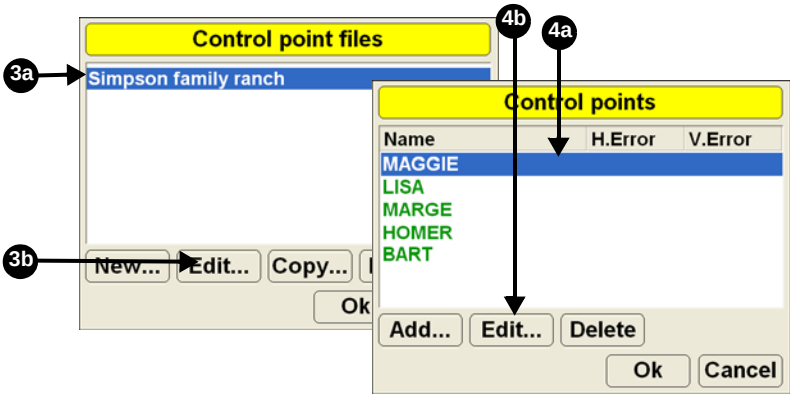


Figure 3-15. Control Point Files Dialog Box

5. Tap in each WGS84 coordinate entry box to display the numeric pop-up keyboard and enter the coordinates for latitude (Lat), longitude (Lon) and height (Hgt) (Figure 3-16).
6. Tap the two GPS localization check boxes to enable (check) them for performing the GPS localization mathematical conversion (Figure 3-16).

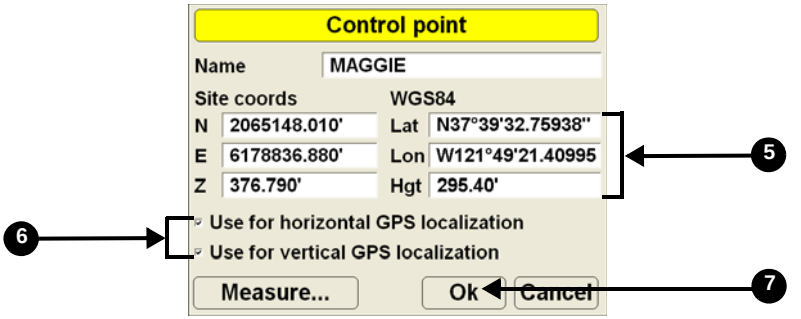


Figure 3-16. Control Point Coordinates and GPS Localization

7. Press **Ok** to return to the ***Control point files*** dialog box.

8. Repeat step 4 and step 7 on page 3-22 for all listed control points. When finished, check the horizontal (H.Error) and vertical (V.Error) values listed on the ***Control points*** dialog box. They should be within acceptable tolerances (Figure 3-17).

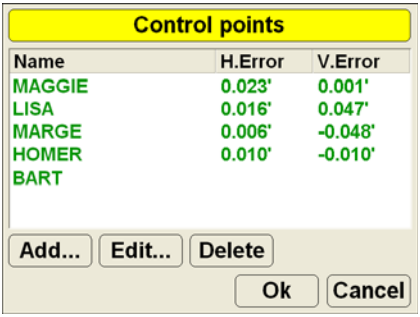


Figure 3-17. Control Point Files with GPS Localization

9. Press **Ok** until you return to the 3DMC main screen, saving the control point localization information and the control points file.

At this time, make a backup copy of the control point file on a CF card.

Surface Files

In mmGPS control applications, the project engineer provides a design surface file for the jobsite. Before paving, the correct file must be copied into the 9168 control box and selected as the surface for the jobsite.

3DMC supports the selection of two design surface files: working and reference. The working surface is the surface that the machine paves to, while the reference surface is simply a visual reference on-screen in relation to the working surface. Typically, the reference surface is an optional selection depending on the requirements of the job while using the 3DMC system. The reference surface could be the final design surface (which may be different than the current, working surface), or could be a surface used to monitor the progress of the current surface.

3DMC also has the ability to create a surface model using a unique, onsite method. The surface model is created on the machine, in real-time, and can be used as a design surface file for grading in 3D GPS/ mmGPS control. Unlike conventional applications using a laser control system, using 3DMC to create a surface model eliminates the required, repetitive setup of a transmitter at the job site.

3DMC can create the following surfaces:

- Flat plane surface – Creates a planar surface with a 0% cross slope and mainfall. This surface is primarily used for building pads.
- Sloping plane surface – Creates a sloping surface with cross slopes and mainfall based on a reference elevation. In paving applications, you can create this surface when a 3D design surface is not available.
- Raise/lower existing surface – Raises or lowers the current surface. This function displays the reference cut/fill value from 0 (zero) rather than the distance between current and selected surfaces.
- Subgrade of existing road – Creates a surface with a cross slope different from the design road surface. For most road surfaces, the cross slopes for the finish design surface is different from the subgrade design slopes.

Working Surface Display Options

When using a TIN surface model file, press **Topcon Logo** ▸ **View** ▸ **Display options** ▸ **Working surface** to display the ***Working surface*** dialog box (Figure 3-18).

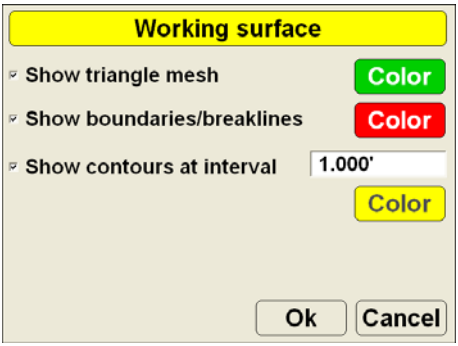


Figure 3-18. Working Surface Display Options

This dialog box has the following selections for displaying information on the main screen (Figure 3-19 on page 3-26):

- Show triangle mesh – displays triangle lines on the Main Screen according to the TIN Surface Model.
- Show boundaries/breaklines – displays boundary lines and breaklines outlining the Design Surface.
- Show contours at intervals – displays contour lines on the Main Screen; tap the entry box to display the numeric pop-up keyboard and specify the elevation spacing interval between lines.
- Color – press to display the ***Color Selection*** dialog box. Tap a color to select it and press **Ok**. You can change the color of the alignment centerline, alignment feature-line, and the station line to the operator's preference, or to maintain consistency between the office and the field.

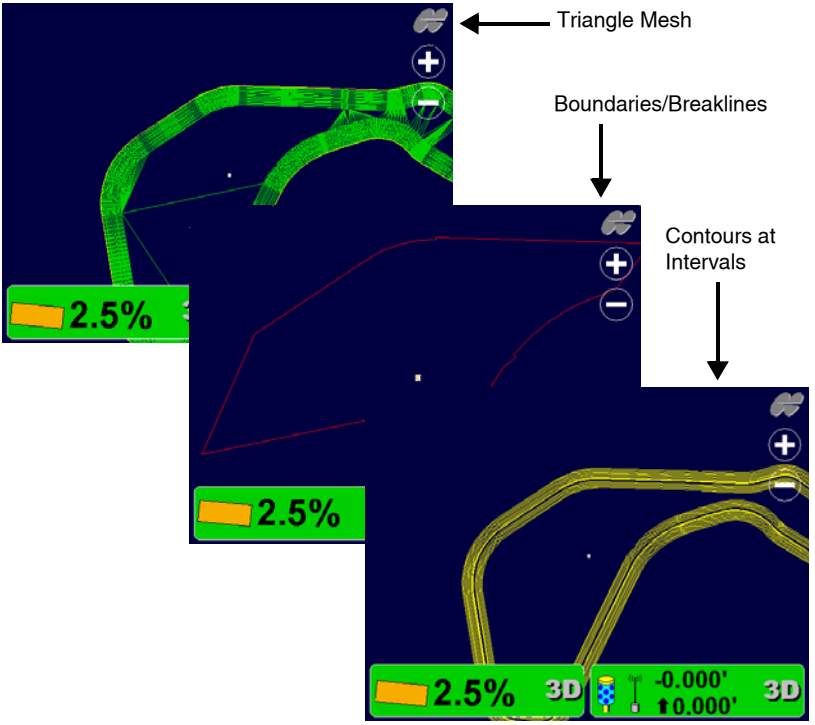


Figure 3-19. Working Surface on the Main Screen

Selecting Surface Files

When setting up 3DMC design files, first select the working surface then select the reference surface.

1. On the 3DMC main screen, press **Topcon Logo** ▸ **File** ▸ **Surfaces** ▸ **Working**.
2. Select the working surface file for the jobsite and press **Ok** (Figure 3-20 on page 3-27).

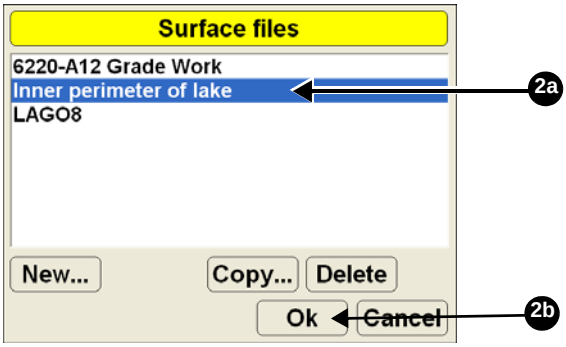


Figure 3-20. Applying a Working Surface File

3. Press **Topcon Logo** ▸ **File** ▸ **Surfaces** ▸ **Reference**.
4. If needed, select the reference surface file for the jobsite and press **Ok** (Figure 3-21).

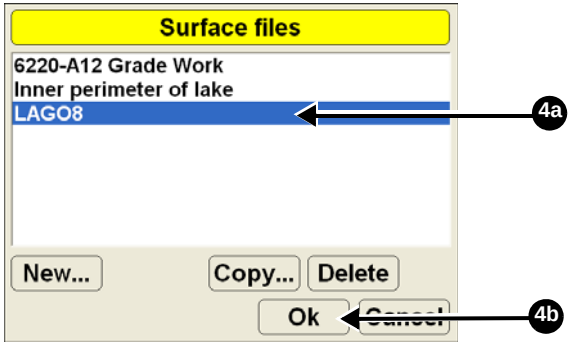


Figure 3-21. Applying a Reference Surface File

Editing a Plane Surface File

Occasionally, a flat or sloping plane surface may need to be adjusted to fit current conditions at the jobsite.

1. On the 3DMC main screen, press **Topcon Logo** ▸ **File** ▸ **Surfaces** ▸ **Working** or **Reference**.
2. Select the plane surface file and press **Edit** (Figure 3-22 on page 3-28).

3. If needed, change the name of the surface. Press **Next**.

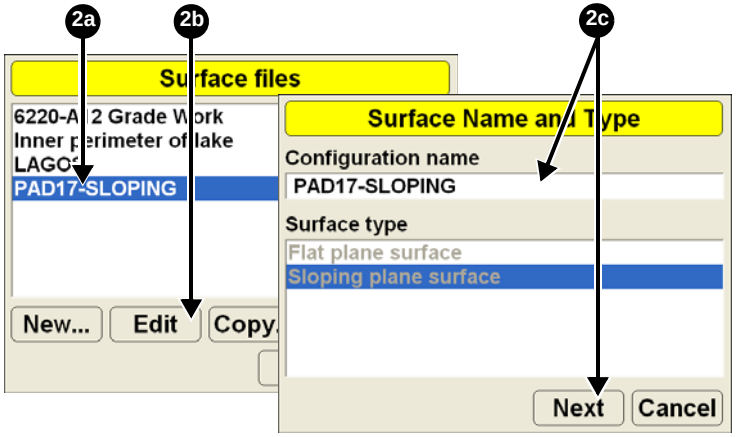
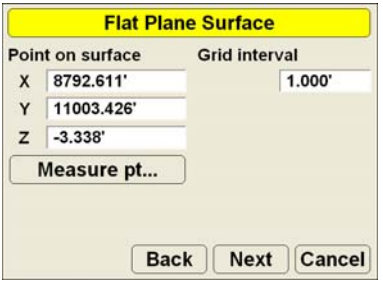
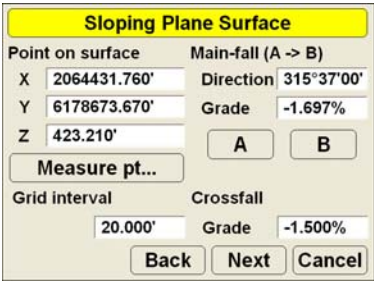


Figure 3-22. Editing a Plane Surface File

4. Depending on the type of plane surface, edit the following properties. Press **Next**, then press **Finish** to save the changes.

Flat Plane Surface	Sloping Plane Surface
• Point on surface • Grid interval	• Point on surface and/or Mainfall direction/grade • Grid interval and/or Crossfall Grade





Creating a Flat Plane Surface

The flat plane surface model is composed of a reference elevation point through which the plane intersects. The operator should be prepared with the elevation reference point to fulfill the requirements for creating the surface.

Figure 3-23 illustrates the factor needed for a plane surface model.

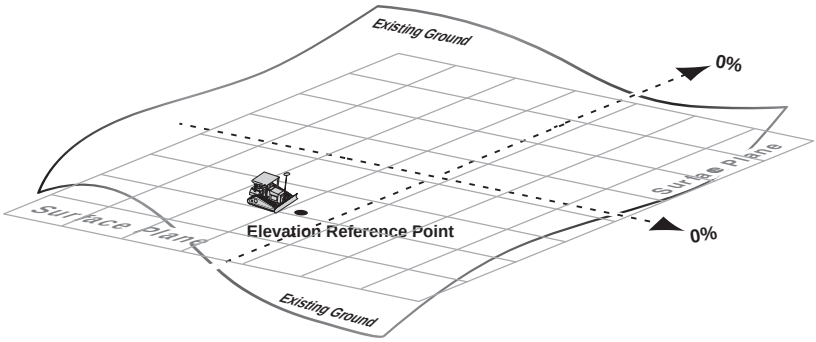


Figure 3-23. Flat Plane Surface Diagram

3DMC accurately measures the point directly below the sensor, but does not compensate for a slant error of the sensor mast. Therefore, for a more accurate measurement, keep the mast as vertical as possible when measuring the point.

1. Press **Topcon Logo ▸ File ▸ Surfaces ▸ Working** or **Reference** and press **New**. Enter and select the following information for the new surface file. Press **Next** (Figure 3-24).
   - Configuration name – enter a name for the file.
   - Surface type – select flat plane surface (no slope).

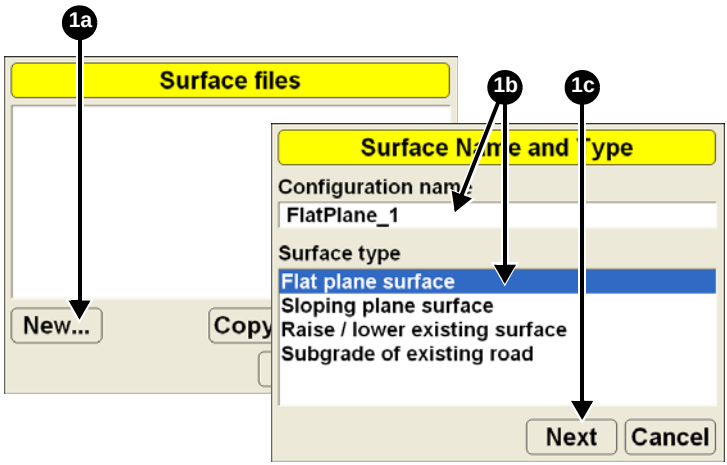


Figure 3-24. Create New Surface File

2. Move the machine to the elevation reference point. The measurement of this point brings the entire plane up or down to intersect the point and determine its relative elevation.

If you have the NEZ coordinates for the elevation reference point, press the corresponding entry box and enter in the information.

3. When the sensor is over the point, press **Measure pt** to measure the elevation reference point (Figure 3-25). The ***Measuring*** dialog box briefly displays.
4. Enter a grid interval for the main screen. Press **Next** (Figure 3-25).
5. Press **Finish** to save the new surface file and end the process.

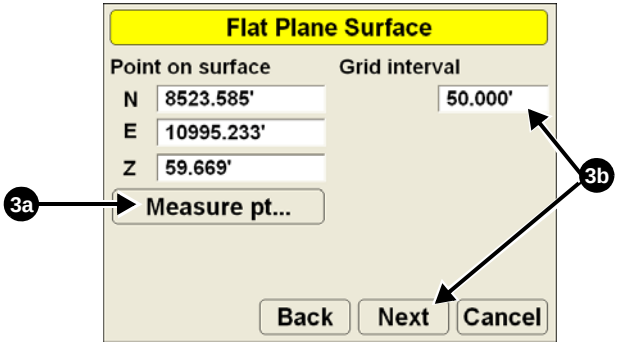


Figure 3-25. Measure Elevation Reference Point and Enter Grid Interval

Creating a Sloping Plane Surface

The sloping plane surface model is composed of four basic factors:

- a mainfall orientation
- a mainfall grade
- a crossfall grade and
- a reference elevation point on the plane.

Just like aligning the rotating laser plane and adjusting the laser receiver height, the operator needs to be prepared with a set of

relative information to fulfill the four factors. This information is composed of three points: A, B, and an elevation reference point.

Figure 3-26 illustrates the basic factors needed for a sloping plane surface model.

The following is the most common method using three reference points prepared at the site: two points (A and B) are measured to determine a Mainfall orientation, and the other point (elevation reference point) is measured to determine an elevation.

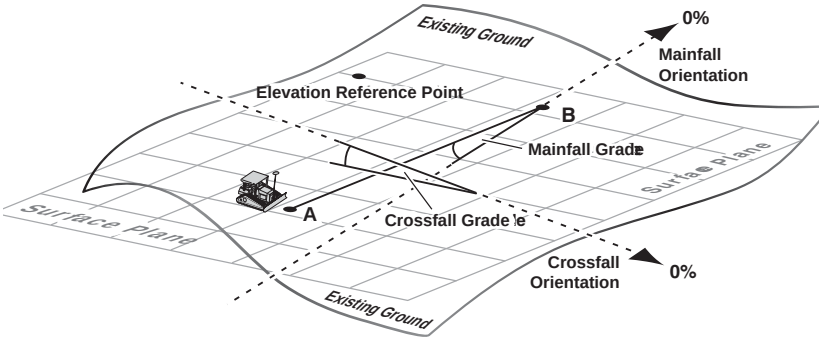


Figure 3-26. Sloping Plane Surface Diagram

3DMC accurately measures the point directly below the sensor, but does not compensate for a slant error of the sensor mast. Therefore, for a more accurate measurement, keep the mast as vertical as possible when measuring the point.

1. Press **Topcon Logo ▸ File ▸ Surfaces ▸ Working** or **Reference** and press **New**. Enter and select the following information for the new surface file. Press **Next** (Figure 3-27 on page 3-32).
   - Configuration name – enter a name for the file.
   - Surface type – select sloping plane surface (compound slope).

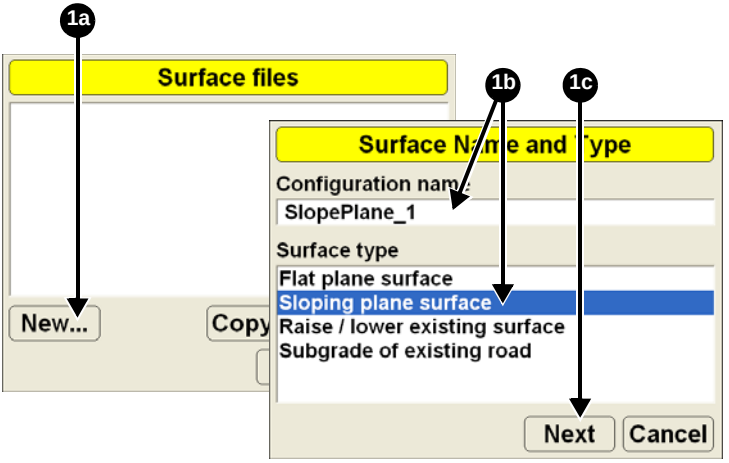


Figure 3-27. Create New Surface File

2. Move the machine to point A and position the sensor on the cutting edge on the selected point.
3. When the cutting edge rests on the point, press **A** to measure the point; the ***Measuring*** dialog box displays during the measurement process (Figure 3-28 on page 3-33).
4. Move to B point and position the sensor on the cutting edge on the selected point.
5. When the cutting edge rests on the point, press **B** to measure the point; the ***Measuring*** dialog box displays during the measurement process (Figure 3-28 on page 3-33).

   Once the A and B point measurements finish, 3DMC determines the Mainfall orientation and grade connecting the A measurement toward the B measurement (see Figure 3-26 on page 3-31).

   If needed, you can re-measure the points; 3DMC saves the A and B point coordinates separately. Also, it allows the operator to manually type in a grade by pressing the entry box.

   A positive sign (+) designates an upgrade from A to B, and the negative (-) sign designates a downgrade from A to B.

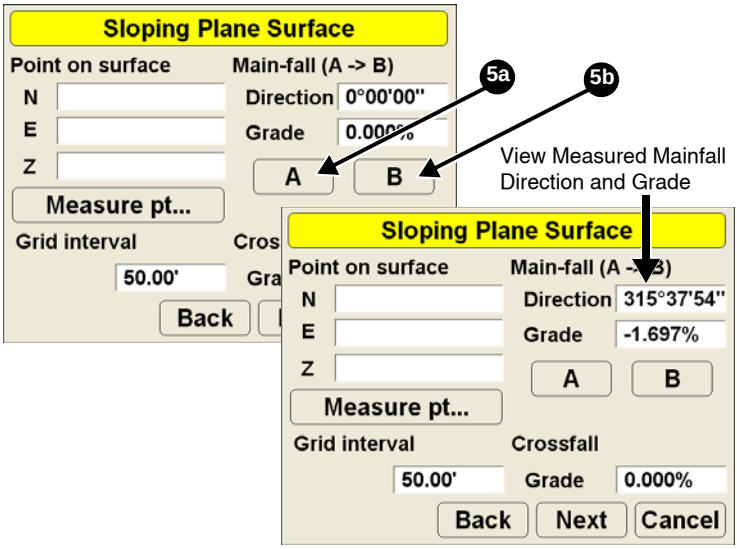


Figure 3-28. Measure Points A and B to Determine Mainfall

6. Press the *Crossfall Grade* entry box and enter a crossfall (Figure 3-29).

   The crossfall grade is the grade that falls across at a 90° angle to the line of Mainfall (see Figure 3-26 on page 3-31), and together with the Mainfall, determines the plane with the compound slope. A positive (+) sign designates a fall from right to left, and a negative (-) sign designates a fall from left to right.

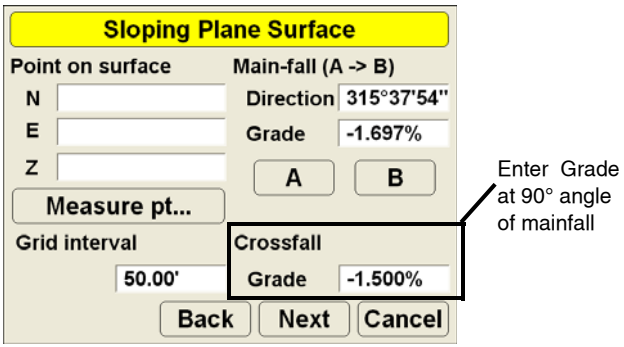


Figure 3-29. Enter Crossfall Grade

7. Move the machine to the elevation reference point. The measurement of this point brings the entire plane up or down to intersect the plane and determine its relative elevation.

Substitute point A or point B for the elevation reference point.

If you have the NEZ coordinates for the elevation reference point, press the corresponding entry box and type in the information.

8. When the antenna rests over the point, press **Measure pt** to measure the elevation reference point (Figure 3-30). The ***Measuring*** dialog box briefly displays.
9. Enter a grid interval and crossfall for the main screen. Press **Next** (Figure 3-30).

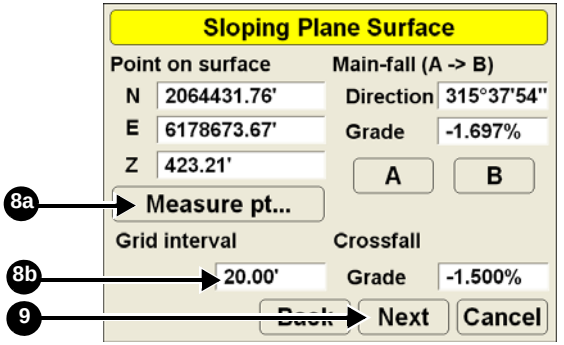


Figure 3-30. Measure Elevation Reference Point and Enter Grid Interval

10. Review the created surface plane (Figure 3-31 on page 3-35). If needed, press **Back** to change parameters or measurements for the surface. Press **Next**.
11. Press **Finish** to save the new surface file and end the process.

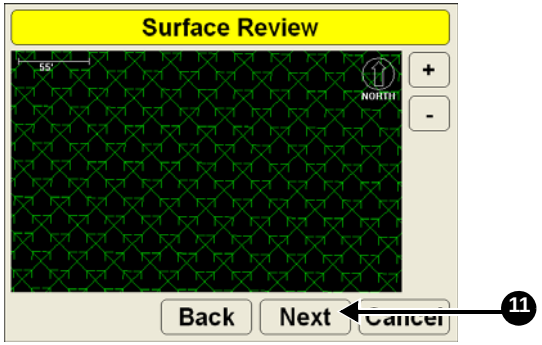


Figure 3-31. Surface Review

Raising or Lowering the Existing Surface

Creating a surface by raising or lowering it based on the current surface allows you to more accurately display current screed information on the screen. For example, if you want to lower a finish grade design surface to 6" below the current surface, lower the surface in 3DMC so that the cut/fill reference is from 0 (zero) rather than from -6" (negative six).

1. Press **Topcon Logo** ▸ **File** ▸ **Surfaces** ▸ **Working** or **Reference** and press **New**. Enter and select the following information for the new surface file. Press **Next** (Figure 3-32 on page 3-36).
   - Configuration name – enter a name for the file.
   - Surface type – select Raise/lower existing surface.

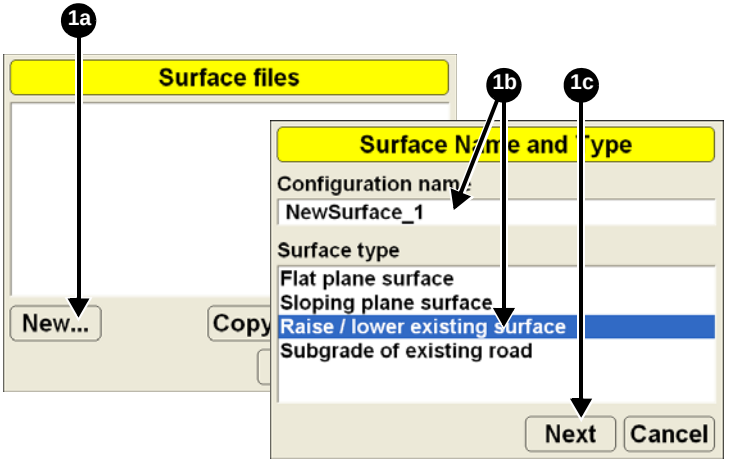


Figure 3-32. Create New Surface File

2. Select the surface to use as the reference from which to raise or lower the new surface (Figure 3-33 on page 3-37).
3. Enter an elevation adjustment. Press **Next** (Figure 3-33 on page 3-37).
   - A positive number raises the subgrade in comparison to the working/reference surface. This value is applied to the centerline of the working/reference surface.
   - A negative number lowers the subgrade in comparison to the working/reference surface. This value is applied to the centerline of the working/reference surface.

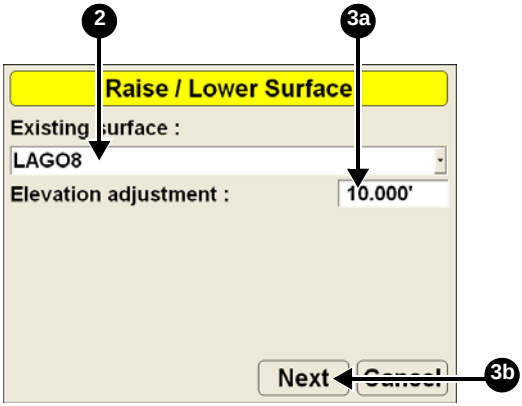


Figure 3-33. Select Existing Surface and Enter Adjustment

4. Press **Finish** to save the new surface file and end the process.

Creating a Subgrade of the Existing Road

Subgrades are temporary, intermediate surfaces that can be selected when building the final design surface (reference surface). A subgrade road that lies below (fill surface) or above (cut surface) the reference surface can be created.

The subgrade road copies location, horizontal and vertical information from the reference surface, and only change the cross section information. This function is only available if the reference surface is a road surface.

1. Press **Topcon Logo** ▸ **File** ▸ **Surfaces** ▸ **Working** or **Reference** and press **New**. Enter and select the following information for the new surface file. Press **Next** (Figure 3-34 on page 3-38).
   - Configuration name – enter a name for the file.
   - Surface type – select Subgrade of existing road surface.

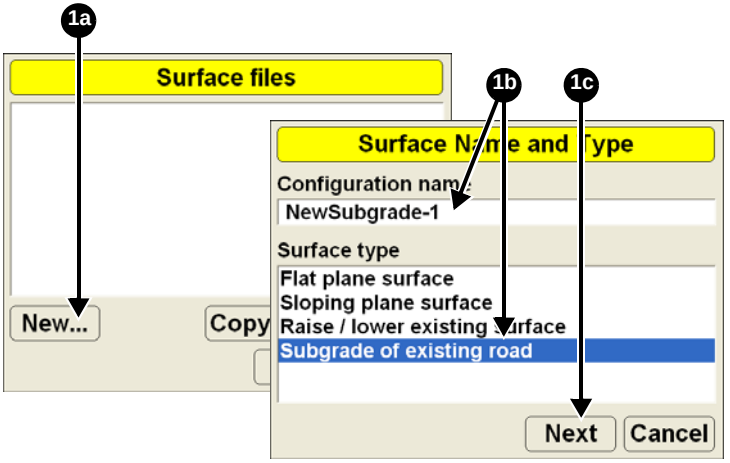


Figure 3-34. Create New Surface File

2. Select the road surface to use as the reference from which to create the surface. Enter an elevation adjustment (Figure 3-35 on page 3-39).
   - A positive number raises the subgrade in comparison to the working/reference surface.
   - A negative number lowers the subgrade in comparison to the working/reference surface.
   - This value is applied to the centerline of the working/ reference surface.
3. Select the type of grade (Figure 3-35 on page 3-39).
   - If selecting Manual, enter the percentage of the left/right side of the subgrade element. This determines the slope for the left/right side of the machine or road.
   - If selecting Copy from, use the gradient (grade) of the reference cross section element that matches the entered offset value (lateral offset from centerline). The left/right grade is copied from the existing road.
4. Select the slope extension for both the left and right side (Figure 3-35 on page 3-39).

- If selecting Vertical, the cross section of the subgrade stops at the same horizontal offset as the cross section of the reference surface.
- If selecting Continue, the last element of both surfaces selected in the "Maximum extension" entry box is continued. Select this option if there are more intersection points expected beyond the end of the cross section.

5. If selecting "Continue" for either the left/right side slope extension, enter the Maximum extension. This is the distance (limit) of how far the extension goes beyond the end of the cross section of the reference surface.

   Maximum extension only active if at least one side has "Continue" selected in the *Extend slope* entry box.

6. Press **Next** (Figure 3-35).

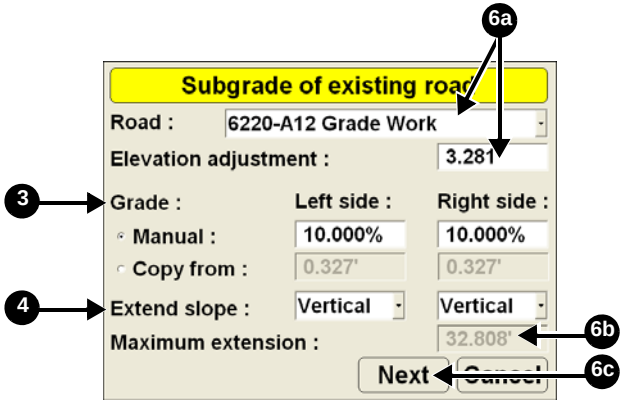


Figure 3-35. Select Grade and Slope Extension Parameters

7. Press **Finish** to save the new surface file and end the process.

On the section view, the new road has the same centerline as the reference surface. The new cross section consists of grade elements with the same user defined grade value (Figure 3-36 on page 3-40) as the subgrade. If the cross section of the new subgrade intersects those of the reference grade, the subgrade shows a new feature line. Dotted lines in the section window indicates surface information outside of the last feature line.

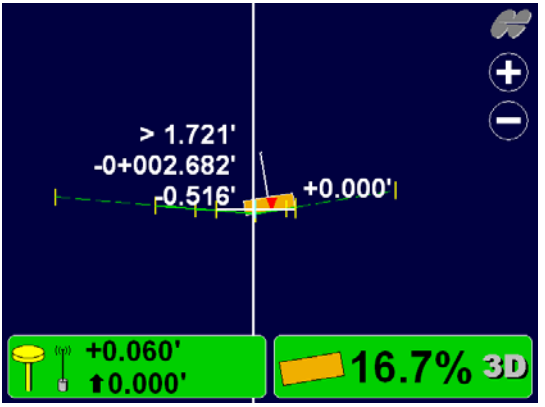


Figure 3-36. New Road Subgrade

Alignment Display Options

When using either a road surface model or an alignment file, press **Topcon Logo ▸ View ▸ Display options ▸ Alignment** to display the ***Alignment*** dialog box (Figure 3-37).

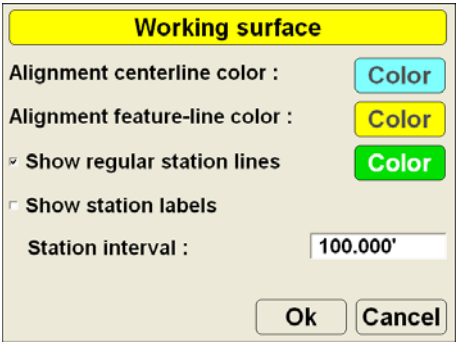


Figure 3-37. Alignment Display Options

This dialog box has the following selections for displaying information on the main screen:

- Alignment centerline color – sets the color of the centerline.
- Alignment feature-line color – sets the color for feature lines.

- Show regular station lines – displays graphical cross lines relative to the horizontal alignments on the main screen. Press the **Station interval entry box** to specify the longitudinal interval between lines.
- Show station labels – displays station labels for each station on the Main Screen.

Linework Display Options

When using a Linework file, press **Topcon Logo ▸ View ▸ Display options ▸ Linework** to display the ***Linework layers*** dialog box (Figure 3-38).

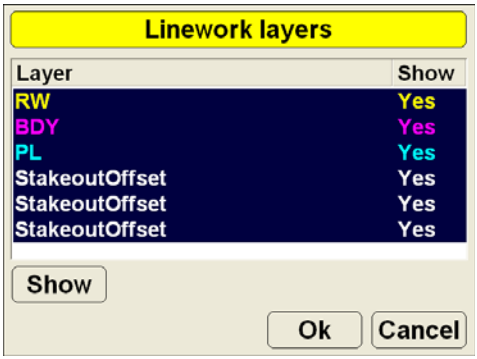


Figure 3-38. Linework Layers

Linework files contains layers composed of a group of lines, each identified with a color. All layers are listed in the ***Linework layers*** dialog box.

1. To display layers on the Main Screen, select the layer and press **Show**, "Yes" displays in the *Show* column. Press **Show** again to not display the layer on the Main Screen; "No" displays in the *Show* column.

2. Press **Ok** to return to the Main Screen (Figure 3-39).

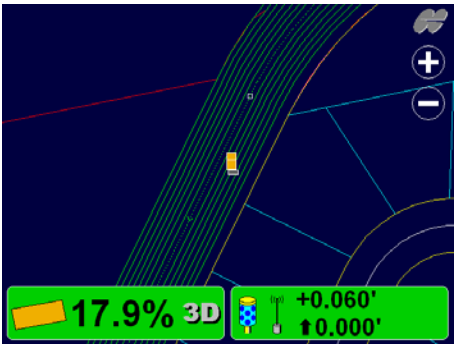


Figure 3-39. Linework Display – Main Screen

Point Display Options

When using a Point file, press **Topcon Logo ▸ View ▸ Display options ▸ Points** to display the ***Points*** dialog box (Figure 3-40).

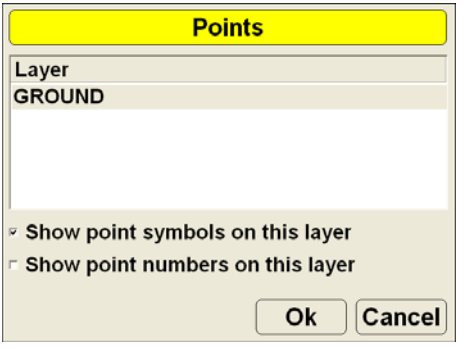


Figure 3-40. Points Display Options

Point files contain information about surveyed points and may represent topographic information, control coordinates, “as-build” information, and so forth. A point file can contain one or more layers.

1. To display the points layer on the Main Screen, select the layer and press **Ok** (Figure 3-40).

2. To display points and/or point numbers (Figure 3-41), select the corresponding check box (Figure 3-40 on page 3-42) and press **Ok**.

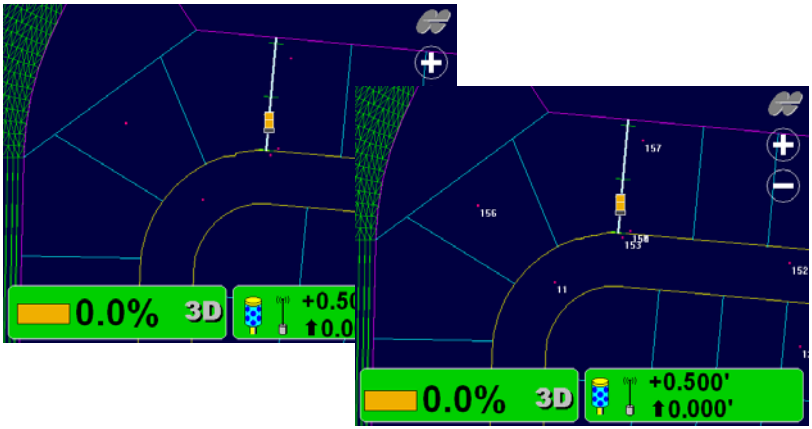


Figure 3-41. Topo Points on Main Screen

Changing the Background Color

Note that changing the background color does not affect the color of linework, TIN, alignments, or point information.

Select a color that contrasts with on-screen information.

1. To change the background color of the Main Screen, press **Topcon Logo ▸ View ▸ Display options ▸ Background color**.
2. Select a color and press **Ok** (Figure 3-42 on page 3-44).

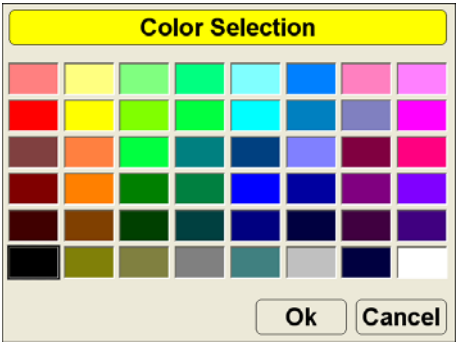


Figure 3-42. Color Selections

Point Files

Points can represent topographic information, backup control coordinates, “as-build” information, and so forth. See “Creating a Points File” on page 2-25 for more information.

Exit 3DMC

To exit mmGPS 3D Paver, tap **Topcon Logo ▸ File ▸ Exit 3DMC** (Figure 3-43).

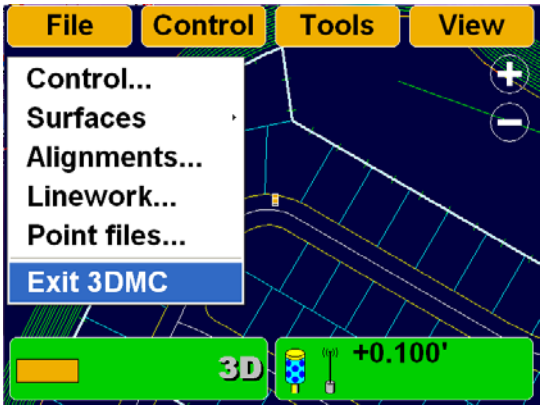


Figure 3-43. Exit 3DMC

Control Menu

In the Control menu, you can create, edit, copy, and delete machine setup files. If a road file is selected as the reference surface, you can set road subgrade properties. It is here also, where the PZS-MC receiver and the PZL-1 laser transmitters are configured. In addition, the slope sensor can be calibrated, valve offsets are applied, and 2D control is enabled.

Machine Setup

The machine configuration file provides vital information about the type of machine, the setup of the components on the machine, machine measurements, and radio configuration information. You must have a machine configuration file before beginning to pave.

Machine configuration files reference the machine and equipment to a mmGPS jobsite for control purposes. For 2D applications, a machine configuration file only determines the machine to display on the screen.

Selecting a Machine Configuration

When selecting a machine file, check that the machine and equipment in the file match the physical machine and equipment setup for the jobsite.

Use the Edit button on the ***Machine files*** dialog box to view the selected configuration's setup screens and parameters.

1. On the 3DMC main screen, press **Topcon Logo** ▸ **Control** ▸ **Machine setup**.
2. Select the machine file and press **Ok** (Figure 3-44).

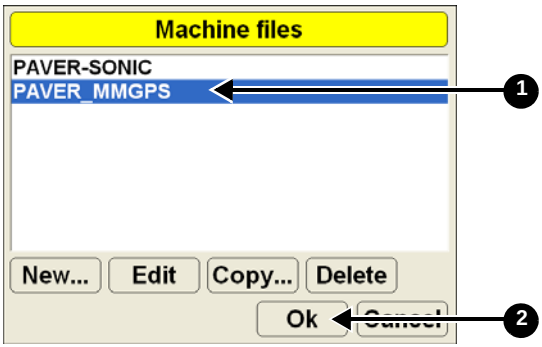


Figure 3-44. Applying a Machine Configuration

Creating a Machine Configuration

1. When the main screen displays, press **Topcon Logo** ▸ **Control** ▸ **Machine setup**.
2. Press **New** and enter or select the following information (Figure 3-45). Then press **Next**.
   - Configuration name – enter a name for the machine

Include the application and/or sensor type in the machine name to easily identify the configuration.

   - Machine type – select the type of machine (Asphalt paver).
   - Sensor – select the type of sensor attached to the machine (GPS antenna).
   - Location – select the sensor's location on the machine (right or left side).
   - Units of measure – select the unit of measure used to take machine measurements (meters, feet, inches, centimeters, feet+inches).

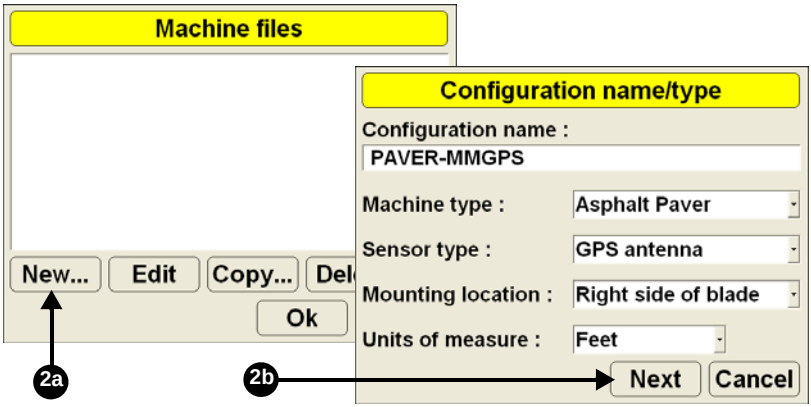


Figure 3-45. Enter Sensor Information

3. Select and enter the following antenna information, then press **Next** (Figure 3-46 on page 3-48). When entering measurements, use the same units of measure selected in the previous step.
   - Antenna – select the type of antenna (Topcon PZS-MC).

- Above (1) – enter the vertical distance from the metal rim of the antenna to the bottom edge of the screed (when elevated to the proper mat thickness).
- Inside (2) – enter the horizontal distance from the metal rim of the antenna to the outer edge of the screed.
- Behind (3) – enter the horizontal distance from the metal rim of the antenna to the back edge of the screed.
- Width (4) – enter the horizontal distance from the left edge to the right edge of the screed.

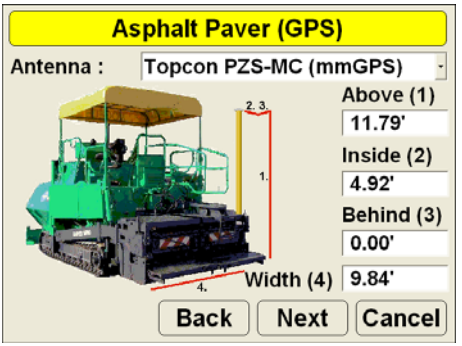


Figure 3-46. Enter Antenna Location Information

NOTICE

Incorrect measurements or data entry errors have a direct affect on paving accuracy. Take each measurement twice to ensure accuracy.

4. Select the GPS precisions for measuring moving and static points. Press **Next** to continue (Figure 3-47 on page 3-49).

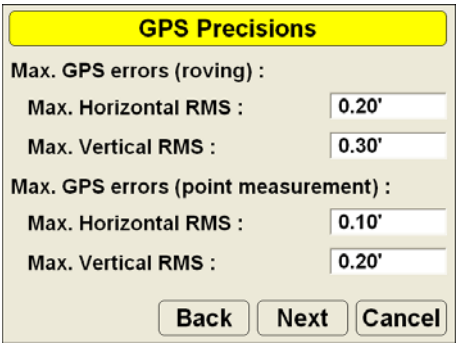


Figure 3-47. Enter GPS Precisions

5. Select the following radio information and press **Next** (Figure 3-48).
   - Radio type – use the same radio type used in the Base setup.
   - Connected to – the serial port the radio is connected to, usually Serial Port B.
   - Baud rate – usually 38400.
   - Format – use the same format used in the Base setup, usually CMR.

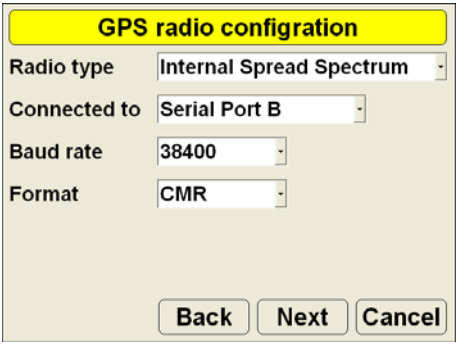


Figure 3-48. Enter Antenna Information

6. For mmGPS configurations, select the following information (Figure 3-49 on page 3-50). Then press **Next**.
   - GPS port – select the port used for GPS communication between receiver and sensor (typically port C).

- Sensitivity – select the sensitivity level for detecting the transmitter, usually Auto. Select a different setting when working at very short or very long distances, or during inclement weather that can affect laser detection.
- Channels – select the channel to scan for mmGPS connection. The "All" selection allows the sensor to independently select the transmitter with the closest proximity to the receiver. If the PZL is not being used in the current setup, it should be deactivated within 3DMC. If setting up only one transmitter, but the job has been configured for multiple transmitters, select the individual ID of the transmitter for the sensor to detect.
- LazerZone aided initialization – select to use the mmGPS signal to assist in initializing the MC-2.5 Receiver Box. This option is useful to decrease the initialization time when satellite visibility is limited (for example, tracking only four or five satellites).
- Calc. LazerZone/GPS weighted elevations – select to combine LazerZone elevations and GPS elevations. When selected, this option forces the receiver/sensor to always consider the angle and distance when determining the elevation, then combine the two elevations accordingly. This option works well at large (300m) distances and steep angles.

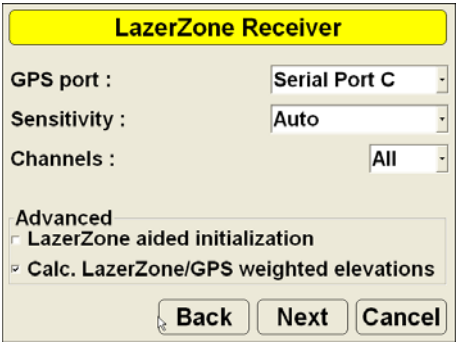


Figure 3-49. Enter Lazer Zone Information for mmGPS Configurations

7. Press **Finish** to save the machine configuration file.

8. Select the machine configuration file on the ***Machine files*** dialog box and press **Ok** to set this as the machine for the job.

You must press Finish to save the file. Failure to do so results in losing all information and require you to repeat the process.

Steer Indication

3DMC can be used to steer the machine to and pave to a polyline layer in the Linework file. Typically, you use an Alignment file to pave along an alignment line. The polylines represent features or objects such as building pads, curbs, sidewalks, top and toe of slopes, or any boundary on the project. If the polyline is composed of three dimensional information at each transition point, it can be selected on the main screen and used as the alignment line to steer to, or can be used as the design elevation to control the screed.

Steer to Polyline

1. Press **Topcon Logo ▸ File ▸ Linework**, select the Linework file for the job, and press **Ok**.
2. Press **Topcon Logo ▸ View ▸ Display options ▸ Linework** and select the polylines to display.
3. View the steering light bar and left section view:
   - **Topcon Logo ▸ View ▸ Lower window ▸ Light bar**
   - **Topcon Logo ▸ View ▸ Left window ▸ Section**
4. Tap and hold the polyline to use for steering to, then tap **Steer to polyline** on the pop-up menu; graphical cross lines display along the selected polyline.

Figure 3-50 shows an example of the main screen after completing the above steps.

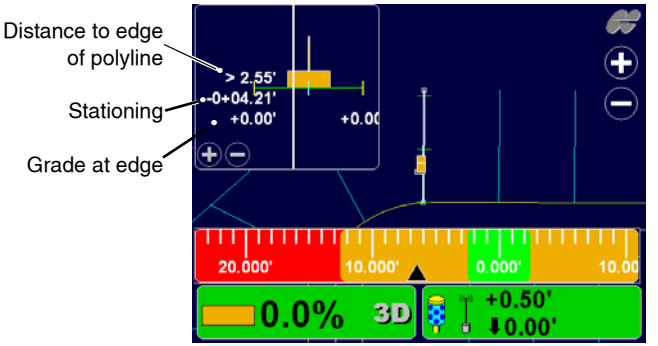


Figure 3-50. Steer to Polyline

5. Press **Topcon Logo ▸ Control ▸ Steer indication** to change the following (Figure 3-51). Press **Ok** when done.
   - Point of interest – the edge of the screed side of the machine to steer from
   - Alignment feature – the feature to steer to
   - Additional steer offset – an offset from the feature to apply

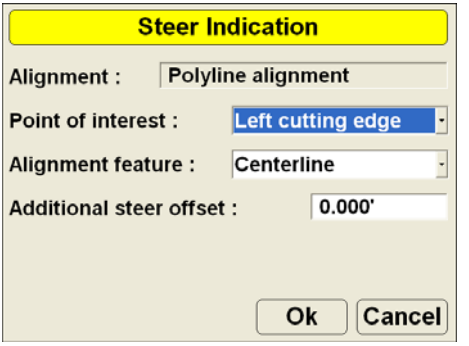


Figure 3-51. Steering Options

6. Press **Topcon Logo ▸ View ▸ Display options ▸ Working surface** to change the color of the centerline, feature-line, or station lines. Also use this screen to show station labels and change the interval between cross lines (Figure 3-52 on page 3-53).

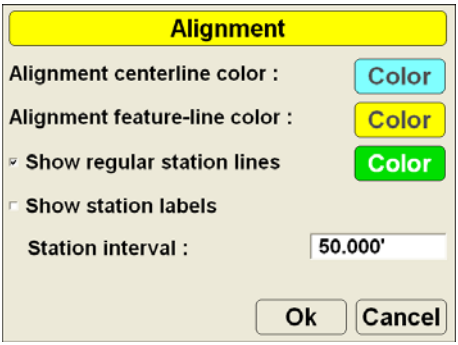


Figure 3-52. Polyline Alignment Options

Begin paving. As needed, repeat step 4 on page 3-51 to steer to another polyline.

PZS-MC Receiver

If needed, you can use 3DMC to temporarily change the settings of the PZS-MC sensor. The original settings (from the machine configuration file) are restored after turning off the 9168 control box.

1. At the control box, press **Topcon Logo ▸ Control ▸ PZS-MC receiver** and select the following receiver parameters (Figure 3-53 on page 3-54):
   - Receiver port – select the port used for GPS communication at the MC-2.5 Receiver Box; usually Serial Port C.
   - Receiver sensitivity – select the sensitivity level for detecting the transmitter, usually Auto. Select a different setting when working at very short or very long distances, or during inclement weather that can affect laser detection.
   - Transmitter selection – select the channel to scan for mmGPS connection. The “All” selection allows the sensor to independently select the transmitter with the closest proximity to the receiver. If the PZL is not being used in the current setup, it should be deactivated within 3DMC. If setting up only one transmitter, but the job has been

configured for multiple transmitters, select the individual ID of the transmitter for the sensor to detect.

- LaserZone aided init – select to use the mmGPS signal to assist in initializing the mmGPS receiver. This option is useful to decrease the initialization time when satellite visibility is limited (for example, tracking only four or five satellites).
- Calc. LaserZone/GPS weighted elevations – select to combine Lazer Zone elevations and mmGPS elevations. When selected, this option forces the receiver/sensor to always consider the angle and distance when determining the elevation, then combine the two elevations accordingly. This option works well at large (300m) distances and steep angles.

2. Press **Ok** to save this information and temporarily overwrite current PZS-MC receiver information.

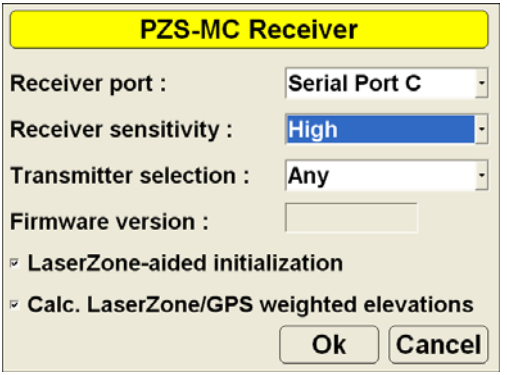


Figure 3-53. Temporarily Change PZS-MC Receiver Information

PZL-1 Transmitters

PZL-1 Transmitter information is saved in the control point file. Ensure the correct control point file is selected for the jobsite.

1. Press **Topcon Logo ▸ Control ▸ PZL-1 transmitters**.
2. Tap the channel tab that corresponds to the channel at the transmitter (Figure 3-54 on page 3-55).

3. Enter the following information and press **Ok** (Figure 3-54).
   - Select the serial number of the transmitter on this channel.
   - Select the control point over which the transmitter is installed.
   - Enter the height of the transmitter.
   - Select the method used to measure the height of the transmitter.

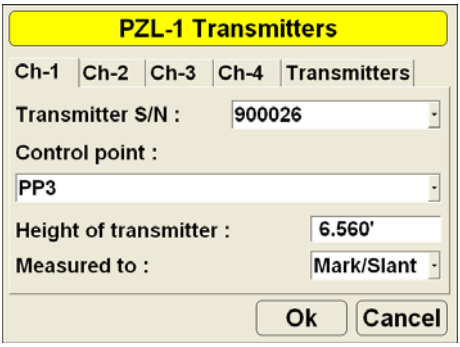


Figure 3-54. Set up PZL-1 Laser Transmitter in 3DMC

Copying PZL-1 Transmitter Information

The control point contains PZL-1 transmitter information. Occasionally, this information may need to be updated, depending on day-to-day operations and possible setups. As the job progresses, the transmitter's position may have to be moved or multiple transmitters set up.

To change the transmitter's channel information, see "Setting up the PZL-1Transmitter in 3DMC" on page 5-14.

To copy transmitter information from an existing control point file, first make sure the control point file has been copied to the control box from Pocket-3D.

1. Press **Topcon Logo ▸ Control ▸ PZL-1 transmitters**.
2. Tap the *Transmitters* tab and press **Copy** (Figure 3-55 on page 3-56).

3. Select an existing control point file that contains mmGPS transmitter data. Press **Ok** (Figure 3-55).

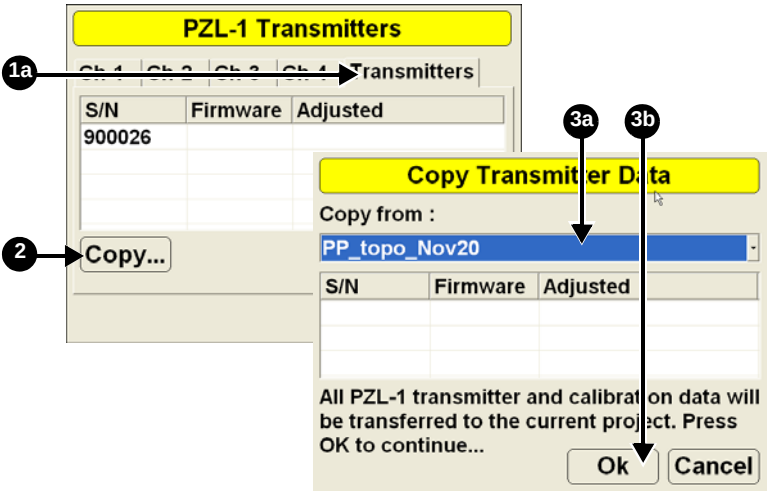


Figure 3-55. Copy Transmitter Data

Calibrate Sensors (Averaging)

The Average setting change the amount of dampening, or filtering, applied to the laser receiver or elevation sensor measurements. Averaging can be thought of as the time period over which a running average of the elevation measurement is calculated.

Averaging Value Range: 1-100

A lower value averages fewer elevation measurements, allowing the system to react more quickly to grade changes.

A larger value averages more elevation measurements, making the system less reactive to fluctuations in grade, such as with laser "beam-bounce" on windy days.

NOTICE Averaging does not affect slope control.

Valve Offsets

The valve offset calibration determines the minimum electrical signal required to begin moving the machine's hydraulic cylinder to return the screed to on-grade. Valve offsets simply determines the electrical requirement, valve gain determines the speed of the cylinder.

The system requires four valve offsets, which must be individually calibrated upon initial setup or after hydraulic maintenance. If valve offsets are set too low, the screed will not reach on-grade. Likewise, if the valve offsets are set too high, the screed moves too far and overshoots on-grade.

Factory preset for valve offsets: 0

Perform valve offset calibrations before adjusting elevation and slope valve gains. If valve offset is altered, valve gain adjustments need to be performed again.

When using the control box on different machines, perform valve offset calibrations and valve gain adjustments for each machine.

1. Raise the screed so that both sides rest a few inches above the ground.
2. At the control box, tap **Topcon Logo ▸ Control ▸ Valve offsets**.

Since the screed is about to move, **automatically**, HANDS and FEET should be clear of the screed!

3. Press the *Raise left* **Set** button to enable the entry box and calibrate the left valve offset value (Figure 3-56 on page 3-58).

   The control box begins sending a raise signal to the left valve and the grade indicators display the currently active offset.

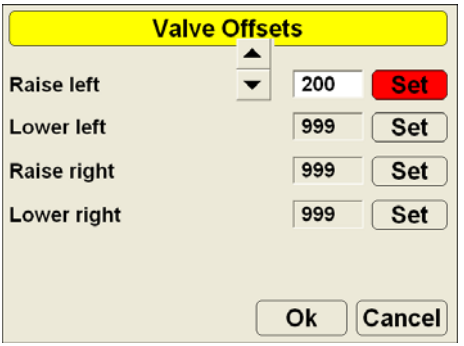


Figure 3-56. Begin Valve Offset

If the screed is moving, turn the Grade Adjustment Knob counterclockwise until the screed stops.

4. Slowly turn the Grade Adjustment Knob clockwise until the screed just begins moving (Figure 3-57).
   - Turning clockwise increases the valve offset value.
   - Turning counterclockwise decreases the valve offset value.

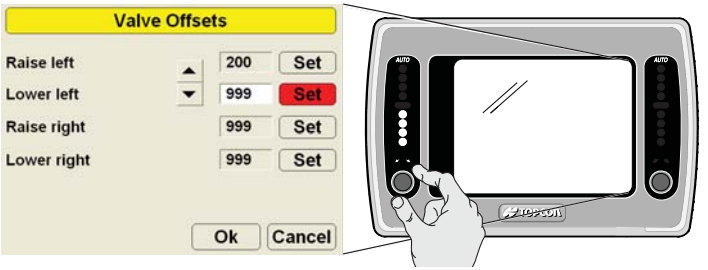


Figure 3-57. Setting Valve Offset Values

5. Press the **Set** key for each of the remaining selections, repeating step 3 on page 3-57 and step 4 above until all four valve offsets are complete.

6. Press **OK** to store the calibrations.

You must press Ok to save and store valve offsets; otherwise, automatic control will not work correctly.

2D Control

When using the mmGPS 3D Paver system for 2D control applications, only the Control menu, the View menu, the Elevation Control key, and the Slope Control key are relevant to 2D control applications. Other files, settings, and selections have no affect in this mode.

Tools Menu

The Tools menu contains options for collecting topographic points, checking the position of the screed, and configuring the radio. This menu is not active for 2D applications.

Topo Survey

3DMC has the ability to perform an “on the fly” topographic survey of the whole project, or any portion thereof. This would be helpful when creating as-build surfaces to determine amount of material to move.

1. Tap **Topcon Logo ▸ File ▸ Point files** to display the ***Point files*** dialog box. Create a new point file or select an existing point file. Press **Ok** to return to the Main Screen.
2. Tap **Topcon Logo ▸ Tools ▸ Topo survey** and enter or select the following information (Figure 3-58 on page 3-60). Press **Ok** when done.
    - Log by – select between minimum distance or time interval:
        – Minimum distance: measures each point at a set distance from the previous logged point.
        – Time interval: measures points at a constant time interval.

- Minimum distance – available when minimum distance selected; enter the minimum distance by which to log points.
- Time interval (secs) – available when time interval selected; enter the time interval in seconds in which to log points.
- Log to layer – stores measured points to the selected layer.
- Log at – determines the measurement point relative to the screed edge.
- Lower all elevations by – used when keeping the machine reference point a certain distance above ground. Manually measure the height between the ground and the target position on the machine reference point, enter the measured height value and press **Ok**. Use a positive value when the screed is above the design surface.

For "Lower all elevations by", always enter a positive value.

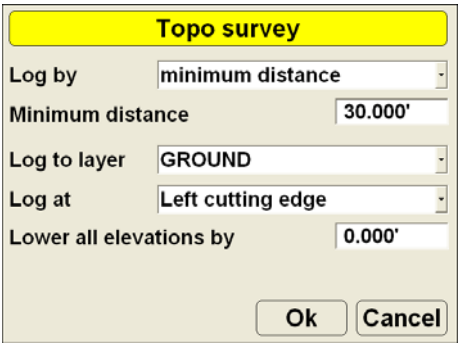


Figure 3-58. Enter Parameters for a Topo Survey

3. Press **Ok** to start the topo survey function.
4. Begin paving. When the machine begins to move, 3DMC begins measuring and logging the data.

5. To stop topo measurements, press **Topcon Logo ▸ Stop topo survey** (Figure 3-59). Otherwise, 3DMC continues to log measurements.

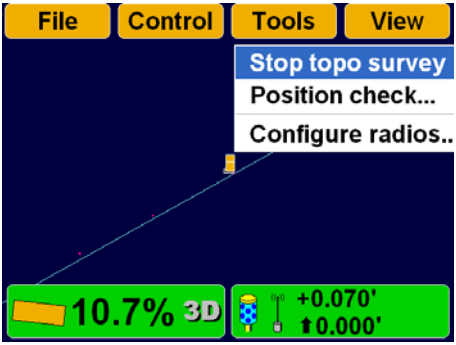


Figure 3-59. Stop Topo Survey

NOTICE

Measurement data is saved in the currently selected point file.

6. Copy the point file to an external memory card for analysis or design work in the office.

Position Check

The position check option provides a daily benchmarking tool to verify that the calculated elevation and position are repeatable.

1. To check the position of the screed, press **Topcon Logo ▸ Tools ▸ Position check**. The Position Check dialog box displays (Figure 3-60 on page 3-62).

2. Select the *Point of interest* (either Left cutting edge, Mid cutting edge, or Right cutting edge), and press **Measure** (Figure 3-60); the ***Measuring*** dialog box displays during measurement.

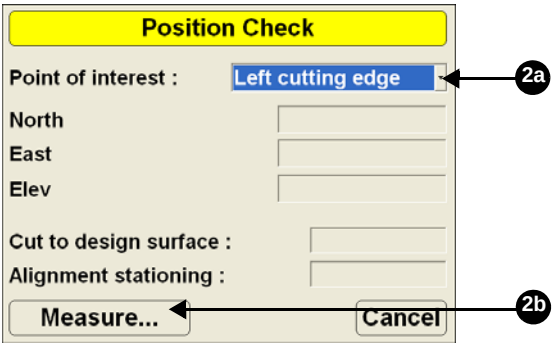


Figure 3-60. Select Point of Interest and Press Measure

3. When finished, the ***Position Check*** dialog box displays the point on the job at the selected edge of the blade (Figure 3-61). Press **Cancel** to return to the Main Screen.

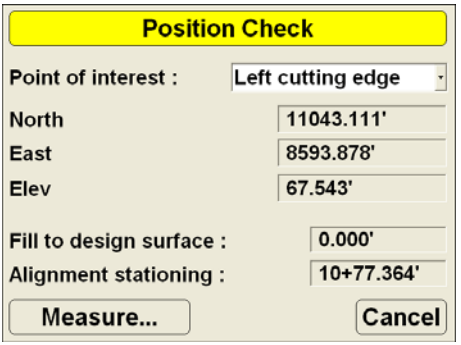


Figure 3-61. Position of Point of Interest

Configure Radios

If needed, you can use 3DMC to temporarily change the radio channel of the radio modems. The MC-2.5 Receiver Box stores radio settings, including the radio channel. The original settings (from the machine configuration file) are restored after turning off then back on the 9168 control box.

Some radio modems, such as Teledesign, have an automatic channel scanning feature, allowing them to automatically detect and connect with a Base Station.

1. Press **Topcon Logo** ▸ **Tools** ▸ **Configure radio** and press **Configure** (if available) to run the radio setting program.

   3DMC may take a few seconds to a few minutes to connect to the radio module and check the current setting. When the current setting is confirmed, the radio's channel and frequency information displays (Figure 3-62).

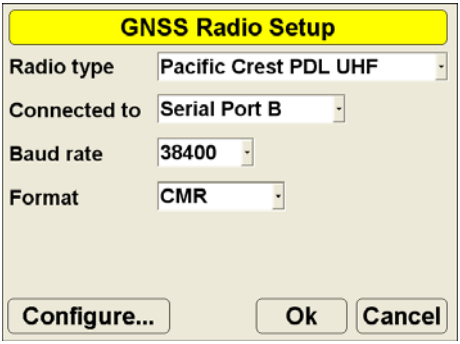


Figure 3-62. Temporarily Change Radio Settings

2. Select the channel number. The frequency of the channel changes automatically depending on the selected channel.
3. Press **Set** to activate and save the new radio channel setting. The radio setting program may take a few seconds to a few minutes to program and complete the process (Figure 3-63 on page 3-64).

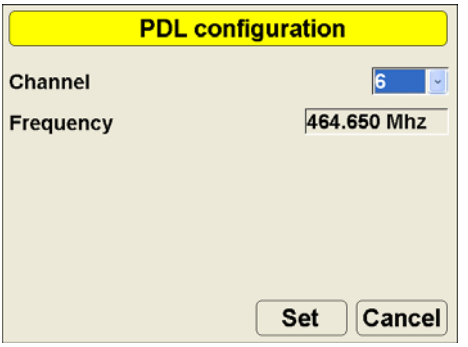


Figure 3-63. Radio Configuration Information

If you have difficulty connecting to the radio module when changing radio configurations, disconnect the radio antenna cable at the MC-2.5 Receiver Box. Signals from the Base Station's radio can interfere with the machine's radio when making changes.

View Menu

3DMC can display several types of views, each of which contain useful information. From the View menu, you can:

- display the Plan, Section, and Profile views in the Main window
- display the Profile, Section, or Grade Indicator from the Left window
- view the grade indicator from the Right window
- display the Profile, Section, Light bar, or Cut/fill history (for mmGPS applications) from the Lower window
- select Display options for various data, depending on the files selected for display
- view 3DMC information, authorization codes, and options.

Main Window

Display options for the main window include a Plan view, a Section view, and a Profile view.

To access the selected main window view, press **Topcon Logo ▸ View ▸ Main window** (Figure 3-64), then tap the appropriate view; a check mark indicates the active view.

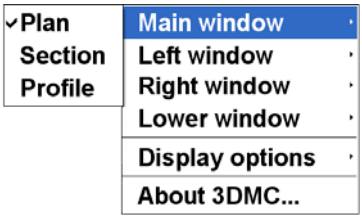


Figure 3-64. Main Window Display Menu Selections

The Plan view (Figure 3-65) displays the jobsite from above the machine, and the main window is always oriented in the forward direction of machine travel.

- The point on the screed below the location of the GPS antenna is always in the center of the main window.
- This view allows for additional representations of triangle mesh and contour lines in a selected color; as well as superimposing Linework, Alignment lines, and Topo points.

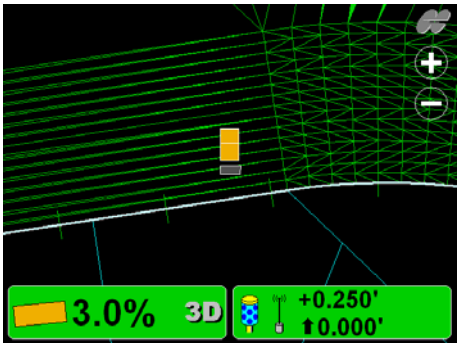


Figure 3-65. Plan View on Main Window

The Section view (Figure 3-66) displays a cross section view of the screed and the selected Design Surface where the right side of the Main Screen is the right side of the screed.

- The cut/fill readings are provided on both sides of the screed and represent how far the screed is from on-grade.
- When a road surface model is selected, the centerline and the elements on the template are presented in red.
- Additionally, the section view displays steering information from a target alignment line to a target edge and the longitudinal distance along the road.

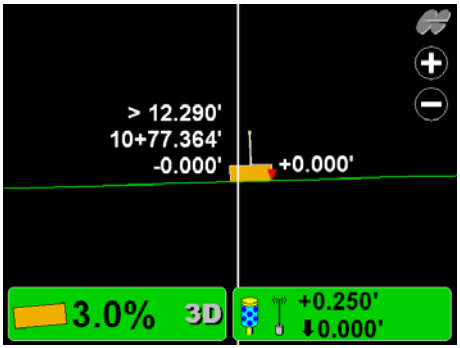


Figure 3-66. Section View on Main Window

The Profile view (Figure 3-67) displays a side view of the machine where the right side of the screen is always the forward direction of machine travel.

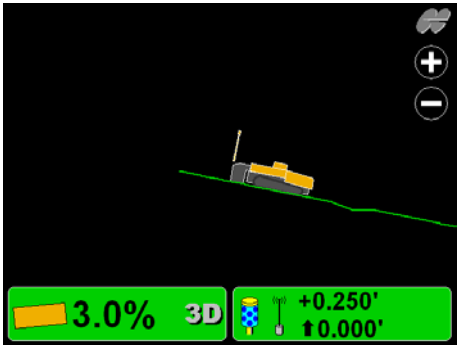


Figure 3-67. Profile View on Main Window

Left Window

Display options for the left window include a Profile view, a Section view, and a Grade indicator.

To access the lower window view, press **Topcon Logo ▸ View ▸ Left window** (Figure 3-68), then tap the view you want; a check mark indicates the active view. None indicates no left window is active.

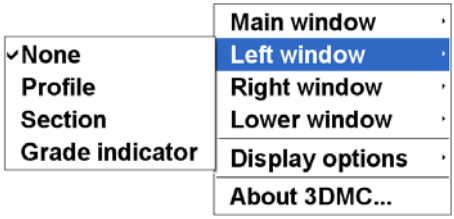


Figure 3-68. Left Window Display Menu Selections

Selecting one of the options adds the view as a window at the left side of the main window (Figure 3-69 on page 3-68).

The Profile view displays a side view of the machine where the right side of the view is always the forward direction of machine travel. The "+/-" buttons increase and decrease magnification for this Left window view.

The Section view displays a cross section view of the screed and the selected Design Surface where the right side of the view is the right side of the screed. The cut/fill readings are provided on both sides of the screed and represent how far the screed is from on-grade. The "+/-" buttons increase and decrease magnification for this Left window view.

The Grade indicator view acts as an infinitely scrolling grade tape, displaying the amount of cut or fill in regards to the design surface. For details on the Grade indicator pop-up menu, see "Changing the Grade Indicator" on page 3-73.

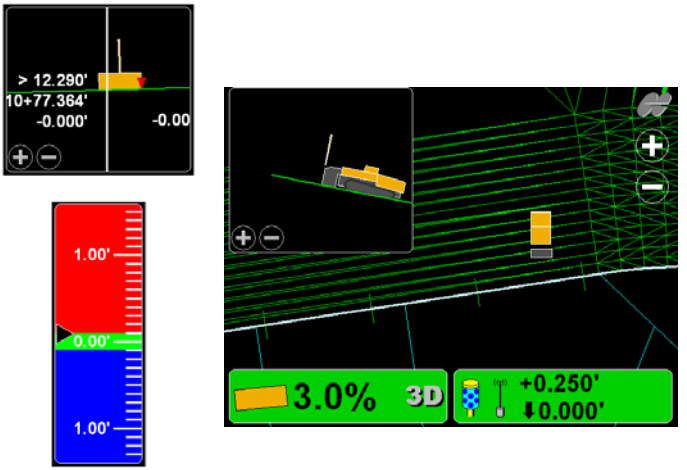


Figure 3-69. Left Window Views

NOTE

The selected Left window view remains visible when showing Right and Lower window views.

Right Window

Only the grade indicator is available as a view in the right window.

To access the right window view, have the Plan view visible and press **Topcon Logo ▸ View ▸ Right window** (Figure 3-70), then tap the view you want; a check mark indicates the active view. None indicates no right window is active.

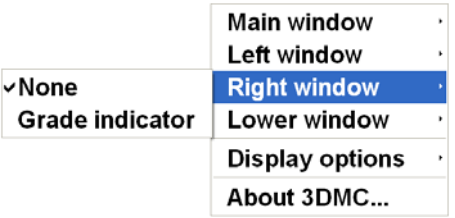


Figure 3-70. Right Window Display Menu Selections

Selecting the option adds the indicated view as a window at the right side of the main window (Figure 3-71 on page 3-69).

The Grade indicator view acts as an infinitely scrolling grade tape, displaying the amount of cut or fill in regards to the design surface. For details on the Grade indicator pop-up menu, see “Changing the Grade Indicator” on page 3-73.

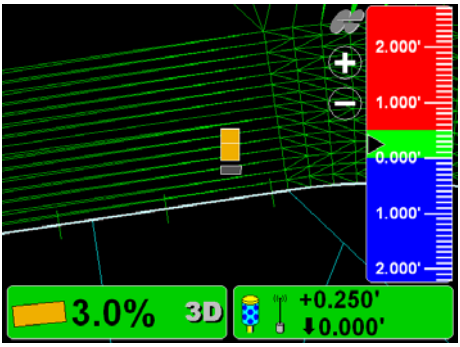


Figure 3-71. Right Window View

The selected Right window view remains visible when showing Left/Lower window views.

Lower Window

Display options for the lower window include a Profile view, a Section view, a Cut/fill history view for mmGPS applications, and a Light bar.

To access the lower window view, press **Topcon Logo** ▸ **View** ▸ **Lower window** (Figure 3-72 on page 3-70), then tap the view you want; a check mark indicates the active view. None indicates no lower window is active.

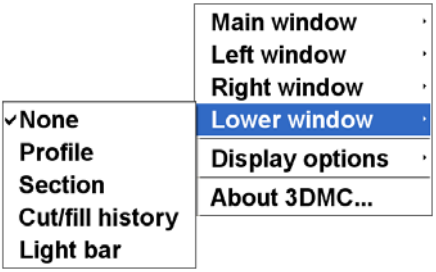


Figure 3-72. Lower Window Menu Selections (incl. mmGPS)

Selecting one of the options adds the view as a small window above the elevation and slope control keys (Figure 3-73 on page 3-71).

The Profile view displays a side view of the machine where the right side of the screen is always the forward direction of machine travel. The "+/-" buttons increase and decrease magnification for this Lower window view.

The Section view displays a cross section view of the screed and the selected Design Surface where the right side of the view is the right side of the screed. The cut/fill readings are provided on both sides of the screed and represent how far the screed is from on-grade. The "+/-" buttons increase and decrease magnification for this Lower window view.

The Cut/fill history view for mmGPS applications displays the on-going highs and lows of the project as determined by both laser and GPS readings. The red line indicates mmGPS detection; the blue line indicates GPS only detection. In the example below, the background color of the main screen was changed to better display the cut/fill history.

The Light bar is used for steering indication where the green zone indicates “on-grade”. For details on the Light Bar pop-up menu, see “Changing the Light Bar Scale” on page 3-75.

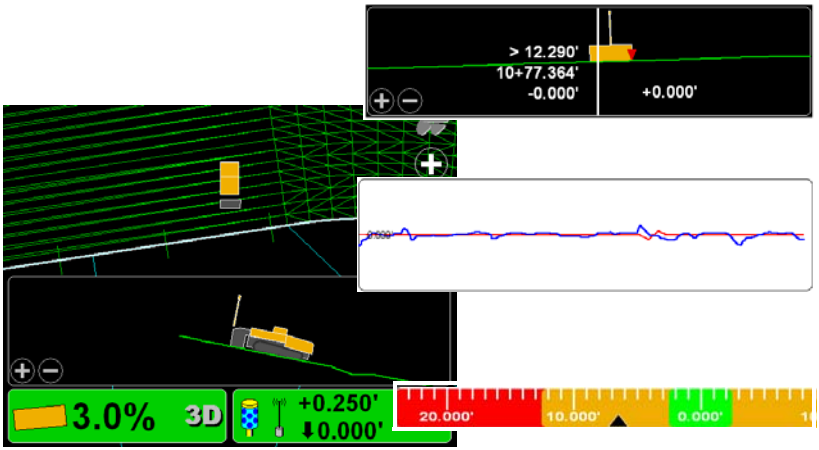


Figure 3-73. Lower Window Views

Display Options

To set the type of units used in the job, press **Topcon Logo ▸ View ▸ Display options ▸ Display units** to display the ***Display Units*** dialog box (Figure 3-74 on page 3-72).

Using this dialog box, change the type of units displayed on the screen, or update preset units in the files currently being used. Note that any conversion will not affect grade accuracy.

- Distances – select either Meters, US survey feet, International feet, or Feet+Inches (measures to a fraction of an inch).

  If using Feet+Inches, all values show as 1'11"1/2 where 12 inches equal 1 foot and any value smaller than an inch shows as a fraction of an inch.

- Distances, decimal places – select the number of decimal places, from zero to four.
- Angles – select either DDº MM’SS”, NDDº MM’SS”, or Gons.
- Grades – select either Percent (%), Run: Rise, or Rise: Run.

- Stations – select either 100.000, 1+00.000, 10+0.000, or 1+000.000.
- Volumes – select either Cubic meters or Cubic yards.
- Coordinates – select either North-East-Elev, East-North-Elev, or X-Y-Z.

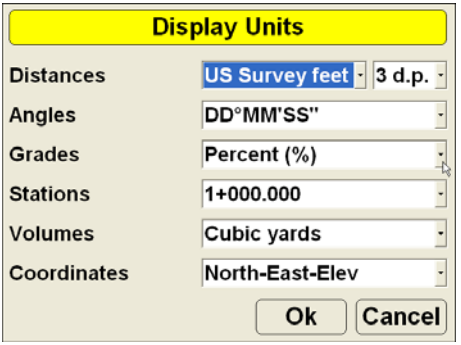


Figure 3-74. Display Units

About 3DMC

To view About 3DMC information, press **Topcon Logo ▸ View ▸ About 3DMC**. The ***About 3DMC*** dialog box displays the version number, copyright date and publisher, and registered user (Figure 3-75).

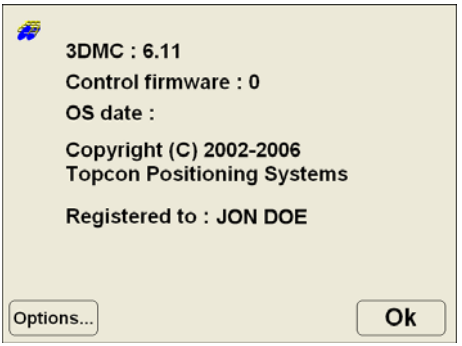


Figure 3-75. About 3DMC Dialog Box

Changing Cut/Fill Offsets

The cut/fill offset can be manually adjusted, on the fly, relative to the Design Surface. After each pass, the cut/fill offset can be updated as necessary while approaching the final design surface.

For safety reasons, 3DMC limits the amount of vertical movement possible while in automatic control. The maximum cut/fill movement (working window) while in automatic is +/- .20 of a foot for 2D control and +/- .40 of a foot for mmGPS control. To pave in automatic within a significant cut or fill, the operator must manually apply a
cut/fill offset.

When changing the cut/fill offset, both the Elevation Control Key and Grade Indicator reflect the new value.

Changing the Grade Indicator

The Grade Indicator acts as an infinitely scrolling grade tape, and displays the amount of cut or fill in regards to the design surface.

To view the grade indicator, press **Topcon Logo ▸ View ▸ Left or Right window ▸ Grade indicator**. This process applies to both the left and right Grade Indicators.

To change the grade display, press and hold the **grade indicator for one second**, tap **Grade display**, then the selected option. This option applies a cut/fill reference for a position on the screed.

- At left edge – the grade tape follows the position at the left edge of the screed.
- In from edge – the grade tape follows a position on the screed, an entered distance from the left edge. Tap to display the numeric pop-up keyboard to enter a distance from the left edge.

The “In from edge” selection determines the point on the screed to measure, regardless of where the elevation point is located.

Example: At Left Edge

When using the Left Edge (Figure 3-76), the grade tape follows the cut/fill status of the left side of the screed, regardless if elevation reference point is at the middle or right edge of the screed. The cut/fill number in the elevation control key is tied directly to the Elevation Reference point.

The Elevation Control Key reflects the elevation reference point.

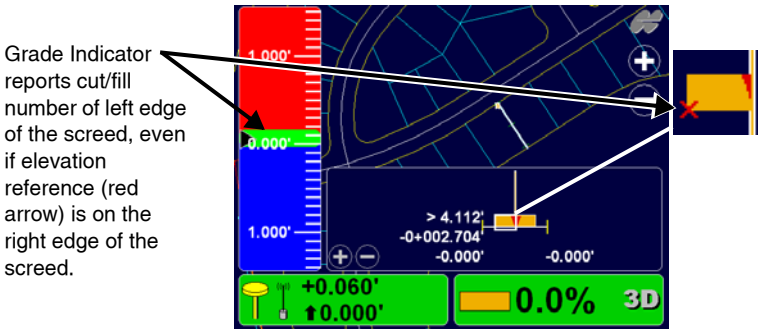


Figure 3-76. Example: Grade Indicator and Left Edge Cut/fill

Example: In From Edge

When using In From Edge (Figure 3-77), the grade tape follows the cut/fill of the entered distance from the left side of the screed, regardless if elevation reference point is at the middle or right edge of the screed. The cut/fill number in the elevation control key is tied directly to the Elevation Reference point.

The Elevation Control Key reflects the elevation reference point.

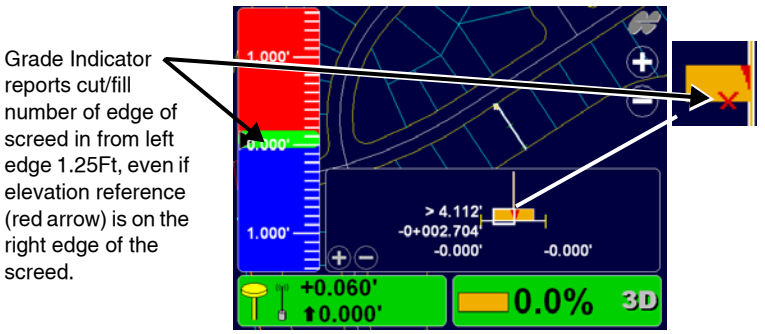


Figure 3-77. Example: Grade Indicator and In From Left Edge Cut/fill

To change the on-grade or extents, press and hold the **grade indicator for one second**, then tap the menu option you want (Figure 3-78).

- On-grade – displays the current on-grade (green zone) width. Tap to change the on-grade zone.
- Extents – displays the current scale (unit spacing) for the grade indicator. Tap to change the unit spacing.

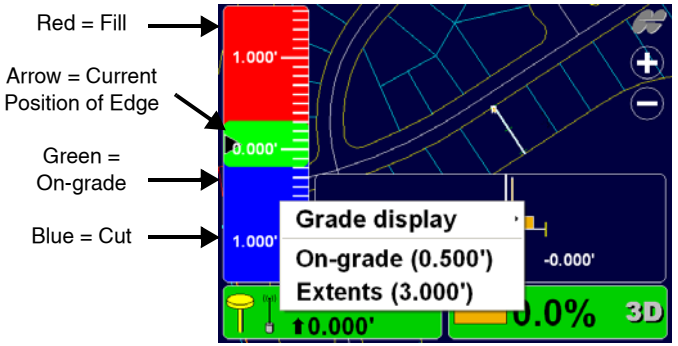


Figure 3-78. Grade Indicator Pop-up Menu

Changing the Light Bar Scale

The light bar displays the distance to the grade reference. Much like the sonic tracker working window (Figure 3-79 on page 3-76), green indicates on-grade status, yellow indicates above grade status, and red indicates below grade or out of range.

To view the light bar scale, press **Topcon Logo ▸ View ▸ Lower window ▸ Light bar** (Figure 3-79 on page 3-76).

To change the light bar scale, press and hold the light bar scale for one second, then tap the menu option of your choice (Figure 3-79 on page 3-76).

- Green – displays the current on-grade (green zone) width. Tap to change the on-grade zone.
- Yellow – displays the current above/below grade (yellow zone) width. Tap to change the above/below-grade zone.

- Extents – displays the current scale (unit spacing) for the light bar. Tap to change the unit spacing.

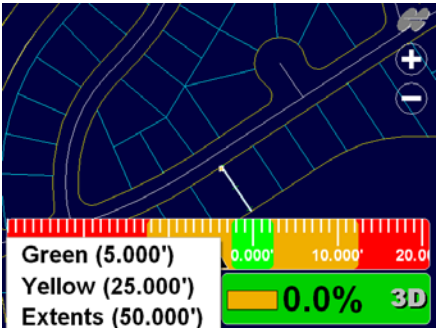


Figure 3-79. Light Bar Scale Indicators

Elevation Control Key

The Elevation Control Key displays elevation offsets. The key also indicates the status of the connected sensor with graphics, informational messages, and colors. The information displayed will be different, depending on the control application (Figure 3-80 and Figure 3-81 on page 3-77).

- Upper number – in mmGPS control, displays the current elevation offset, and can be changed at any time. If the machine is incapable of paving to the design elevation, the operator dials an offset into 3DMC, raising or lowering the design surface for a more manageable surface.
- Lower number – in mmGPS control, displays the current surface reading. The number continuously updates according to the elevation difference between the screed edge and the design (reference) surface.
- Single number – in 2D control, displays the current elevation setting, and can be changed at any time.
- Elevation Control Key color – the background color of the elevation control key indicates sensor status.
  - Green: indicates sensor status suitable for paving.

  - Red: indicates an error status and automatic control will be disabled.
  - Orange: in mmGPS applications, indicates low GPS precisions.

- Icon color – for mmGPS applications, the icon color will be BLUE when the system is receiving a mmGPS signal, and GRAY when a mmGPS signal is unavailable.
- Icon status – a crossed out icon indicates the corresponding sensor/receiver is not available. A flashing radio icon indicates the radio link is between three and ten seconds old (weak signal).

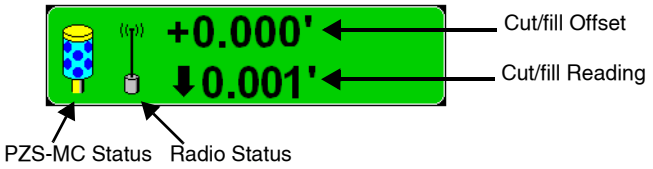


Figure 3-80. Elevation Control Key for mmGPS Applications

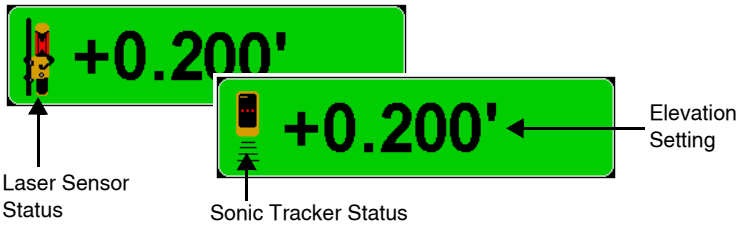


Figure 3-81. Elevation Control Key for 2D Applications

The Elevation Control Key also provides access to elevation information and elevation configuration functions. The information and available selections depend on the current control application, and are described in the following sections.

Adjust Elevation in mmGPS Control

To display the following elevation settings for mmGPS applications (Figure 3-82), press the **Elevation Control Key**:

- Elevation (left edge) – displays the elevation of the left edge of the screed based on local site coordinates.
- Elevation (right edge) – displays the elevation of the right edge of the screed based on local site coordinates.
- Elevation valve gain – displays the current valve gain setting for elevation control. The valve gain setting determines the speed of the hydraulic response during automatic control. A higher setting speeds up the response; a lower setting slows down the response.
- Elevation set point – displays the current elevation offset, or amount of additional height applied to the design surface.
- Match – sets the current design surface to the elevation of the screed, changing the elevation offset to zero. The surface offset number then displays the distance from the new, matched grade to the original design surface. This key allows you to quickly adjust the machine to a more manageable surface.
- Zero – sets the elevation set point value to zero.
- GPS info – displays the GPS information dialog box; see "Viewing GPS Information" on page 3-82 for details.

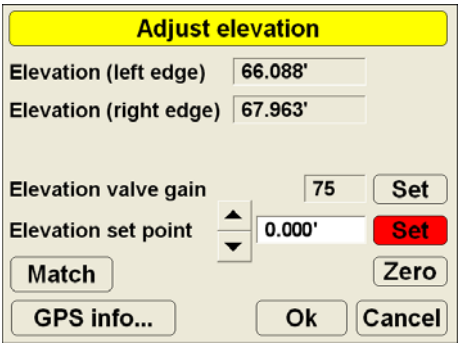


Figure 3-82. Adjust Elevation Dialog Box – mmGPS Control

Adjust Elevation in 2D Control

To display the following elevation settings for 2D applications (Figure 3-83), press the **Elevation Control Key**:

- Elevation (left edge) – disabled for 2D control.
- Elevation (right edge) – disabled for 2D control.
- Elevation valve gain – displays the current valve gain setting for elevation control. The valve gain setting determines the speed of the hydraulic response during automatic control. A higher setting speeds up the response; a lower setting slows down the response.
- Survey – used to quickly lock the screed on-grade.
- Change to Slope – used to switch to 2D slope control.

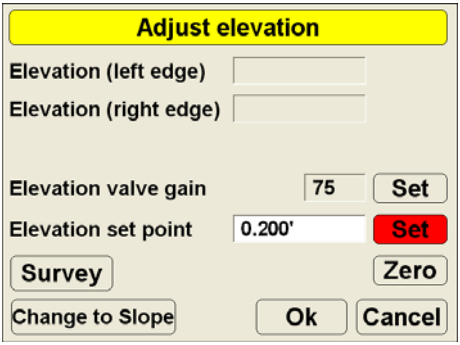


Figure 3-83. Adjust Elevation Dialog Box – 2D Control

Changing Offsets Using the Elevation Control Key

1. On the 3DMC Main Screen, press the **Elevation Control** key.
2. Press the *Elevation set point* **Set** key, changing it to red (Figure 3-84 on page 3-80).

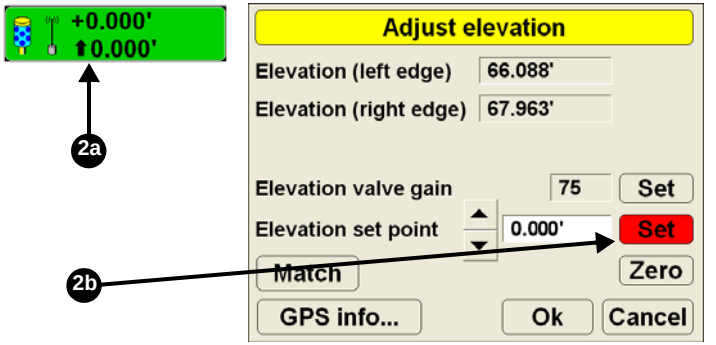


Figure 3-84. Press Elevation Control Key then Set

3. Change the offset using the numerical keyboard or the up/down arrows next to the entry field.

   Press the *Elevation set point* entry box, tap in a new offset value, and press **Ok** (Figure 3-85). A negative value is a Cut; a positive value is a Fill.

Figure 3-85. Use Numeric Keyboard to Change Offset

4. Press **Ok** to set the new offset value and return to the 3DMC Main Screen.

Adjusting Valve Gain

A Valve Gain adjustment allows the operator to speed up or slow down the response of the hydraulic valves, and can be adjusted on the fly while in Automatic Control.

- If the screed seems to be moving too slow and the Grade Indicators take too long to reach on-grade, increase the gain value to cause the hydraulics to respond faster.
- If the screed is moving too fast and the Grade Indicators run past on-grade, decrease the gain value to cause the hydraulics to respond slower.

To change the valve gain, first change the elevation valve gain, then change the slope gain.

1. On the 3DMC Main Screen, press the **Elevation Control** key.
2. Press the *Elevation valve gain* **Set** key, changing it to red (Figure 3-86).

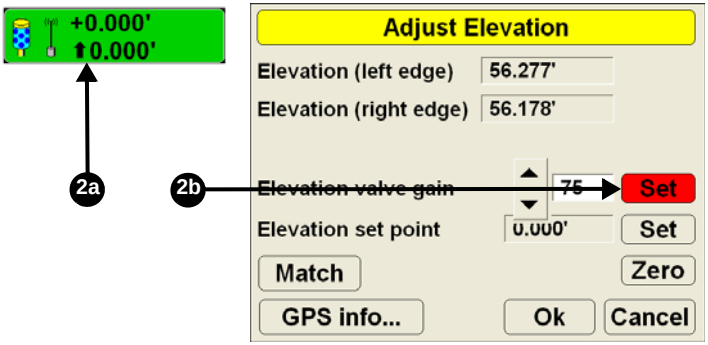


Figure 3-86. Press Elevation Control Key then Set

3. Change the offset using the numerical keyboard, the **+/-** buttons on the joystick, or the up/down arrows next to the entry field.
   - Press the *Elevation valve gain* entry box, enter a new offset value on the numeric keyboard, and press **Ok** (Figure 3-87 on page 3-82). A negative value is a Cut; a positive value is a Fill.
   - Press the **+/-** buttons on the joystick to quickly increase or decrease the offset value.

Figure 3-87. Enter New Offset on Numeric Keyboard

4. Press **Ok** to set the new offset value and return to the 3DMC Main Screen.

Viewing GPS Information

To view the ***GPS information*** dialog box and tabs, press the **Elevation control** key, then press the **GPS info** button (Figure 3-88).

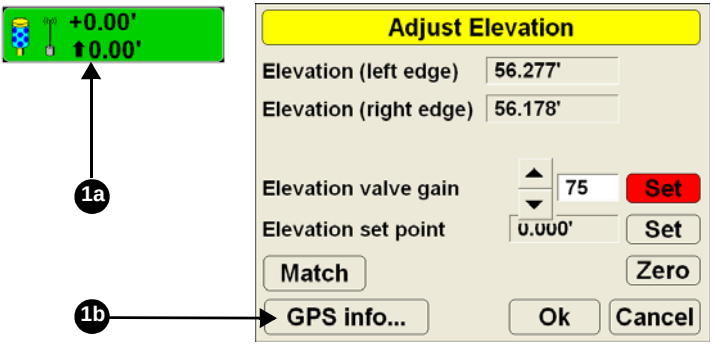


Figure 3-88. View GPS Information

The following sections describe the ***GPS information*** tabs.

GPS Status and Quality

The *Fix* tab displays satellite status and positioning quality based on GPS satellites currently being tracked (Figure 3-89). Once a GPS solution is initialized, 3DMC reports the Fix status. The positioning quality is an estimation computed from valid satellite status (RMS: Root Mean Square).

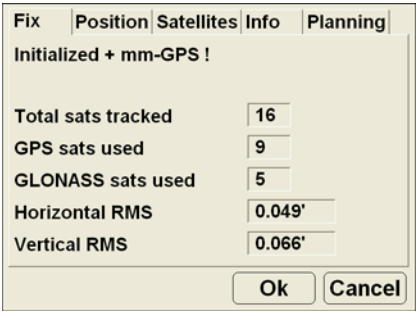


Figure 3-89. GPS Info – Fix Tab

Screed Edge Position

The *Position* tab displays current locations for the left and right sides of the screed (Figure 3-90). These values are based on the local site coordinates, providing quick position and elevation checks at particular points on the project. The "Z" values on this tab match the elevation numbers on the ***Adjust elevation*** dialog box.

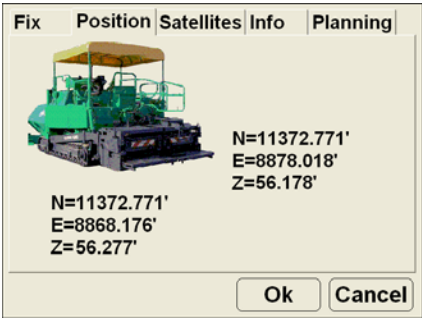


Figure 3-90. GPS Info – Position Tab

Monitor Satellites and Enter Mask Angle

To monitor the current distribution of satellites or enter the mask angle for satellites, press the **GPS status** button, then tap the *Satellites* tab on the ***GPS status*** dialog box.

The *Satellites* tab displays the following information (Figure 3-91):

- Satellite plot – displays used and unused satellites, and the current mask angle.
  - Blue dots: GPS satellites
  - Red-with-cross dots: GLONASS satellites
  - Black dots: unused satellites
  - Red mask circle: satellites inside are used for positioning
- Mask angle – enter the mask angle for the jobsite.

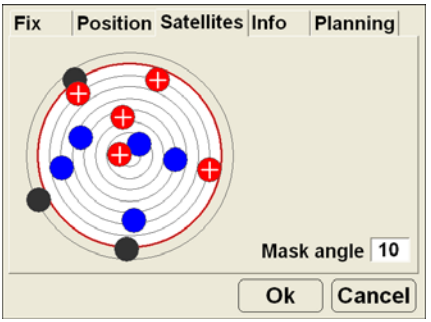


Figure 3-91. GPS Info – Satellites Tab

View Receiver Information or Reset Receiver

The *Info* tab displays the following (Figure 3-92 on page 3-85):

- Identification information, firmware revision, and radio link information (type, latency, and quality) for the GPS receiver in the MC-2.5 Receiver Box.
- Reset RTK – press to reset RTK ambiguities.
- Reset receiver – press to clear all data and reset all settings stored for the MC-2.5 Receiver Box.

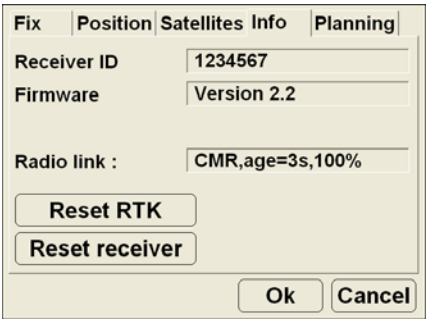


Figure 3-92. GPS Info – Info Tab

Satellite Planning Information

The *Planning* tab displays the estimated grading precisions on an hourly scale (Figure 3-93).

- Press the **Next** key to display the chart for the next day.
- Press the **Prev** key to display the chart for the previous day.

The *Planning* tab provides useful information for predicting GPS solution accuracy for paving. The red vertical line marks the current time.

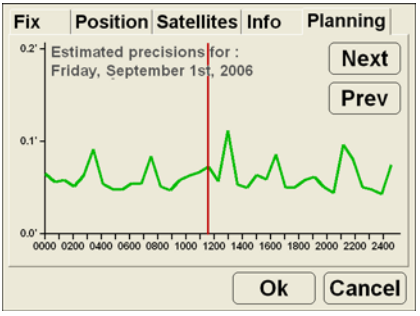


Figure 3-93. GPS Info – Planning Tab

Viewing and Updating 3DMC Options

3DMC software uses authorization codes to enable the options screen. For most applications, these codes are initially entered at the factory, but should be updated if updating the options for other application functions.

1. To view information about 3DMC, press **Topcon Logo** ▸ **View** ▸ **About 3DMC**. The ***about 3DMC*** dialog box displays version number, copyright date and publisher, and registered user (Figure 3-94).
2. To view the enabled options, press **Options** on the ***about 3DMC*** dialog box (Figure 3-94).
3. To modify 3DMC options, press **Modify** on the ***Options*** dialog box (Figure 3-94).

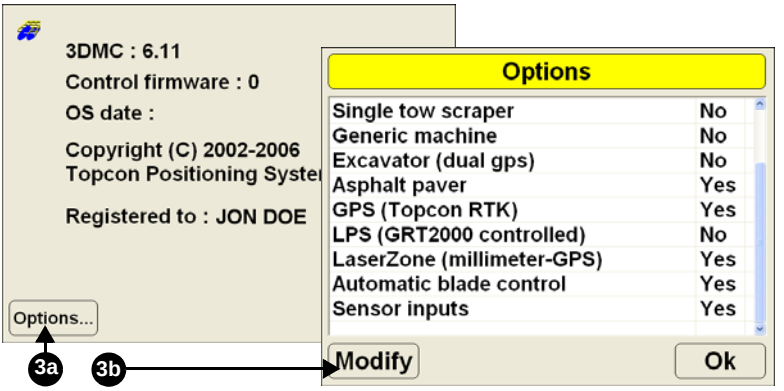


Figure 3-94. About 3DMC and 9168 Control Box Options for 3DMC

4. From the ***ControlBox*** dialog box, record the *Device identification* number to give to your Topcon representative. Contact your Topcon representative to obtain new authorization codes for the selected applications.
5. When you have received the new authorization codes, enter the codes in the ***ControlBox*** dialog box using the alpha-numeric keyboard (Figure 3-95 on page 3-87).

6. Press **Ok** to apply the new codes and options. Press **Ok** on each screen to return to the Main Screen.
7. Turn off the control box, wait a couple seconds, and then turn on the control box to activate the new passwords.

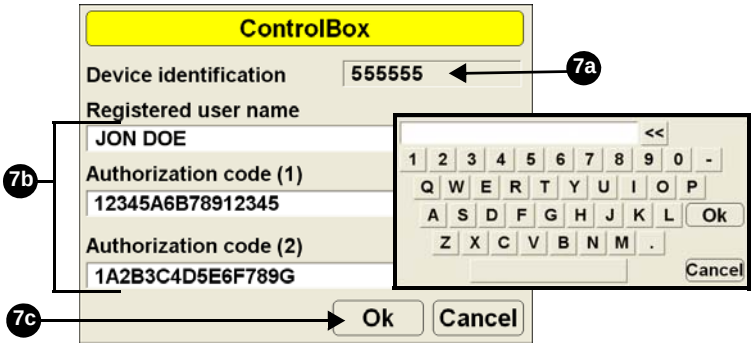


Figure 3-95. Enter New Authorization Codes

Setting the Elevation Offset and Locking On-grade

Once the Sonic Tracker has been positioned over the reference, the control box is used to set the Sonic Tracker to on-grade.

Use “zero” as the on-grade reference.

1. Set the sonic tracker over the grade reference point.
2. Position the screed at a known height, typically just above the surface.
3. Press the **Elevation Control key**, then press the *Elevation set point* **Set** button. Enter the elevation offset using the pop-up keyboard or the up/down arrows (Figure 3-96 on page 3-88).
4. Press **Survey** to quickly lock on-grade (Figure 3-96 on page 3-88).

5. Press **Ok** to return to the main screen (Figure 3-96).

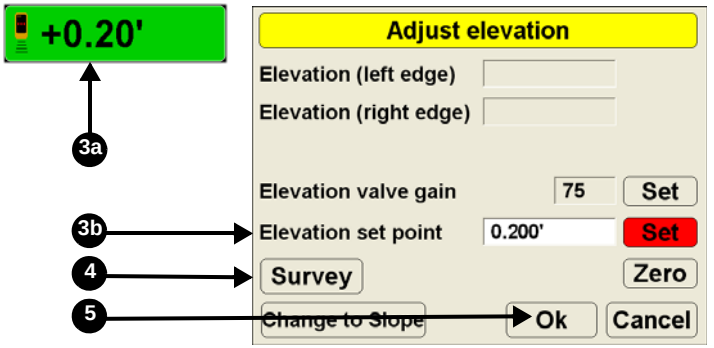


Figure 3-96. Survey On-grade – Elevation Example

When changing the depth of the mat being laid, the speed of turning the Grade Adjustment knob determines the smoothness of the transition from one depth to another.

Slope Control Key

The Slope Control Key displays the design (reference) cross-slope and indicates sensor status with graphics, messages, and colors (Figure 3-97 on page 3-89). While paving, the design cross-slope continuously changes according to the design surface.

- Design Cross Slope – displays the current cross slope. In mmGPS, this number is based on the design (reference) surface; in 2D, the operator enters the number.
- Type of Control Application – displays either mmGPS or 2D for the current control application.
- Color of Slope Key – the background color of the Slope Control Key indicates sensor status.
  - Green: indicates sensor status suitable for paving.
  - Red: indicates an error status and Automatic Control is disabled.

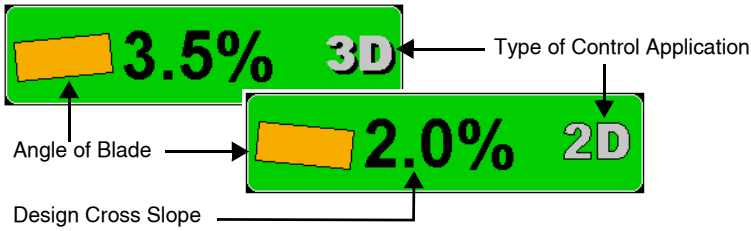


Figure 3-97. Slope Control Key

Adjust Slope in mmGPS Control

To display the following slope settings for mmGPS applications (Figure 3-98 on page 3-90), press the **Slope Control Key**:

- Blade slope – the current percentage of slope for the slope sensor.
- Mainfall slope – only for graders; the current degree of rotation for the rotation sensor.
- Slope gain – displays the current valve gain setting for slope control. The valve gain setting determines the speed of the hydraulic valve response while in automatic control. A higher setting speeds up the response; a lower setting slows down the response.
- Slope locked – used to pave at a constant (fixed) slope, keeping the elevation side in mmGPS control. Enabling the check box locks the cross slope to the value entered into the box. The screed stays at the same slope until the percentage of slope changes using the grade adjustment knob, or entering a new value in the slope locked box.

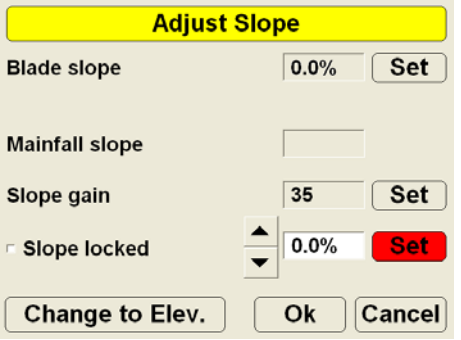


Figure 3-98. Adjust Slope Dialog Box – mmGPS Control

Adjust Slope in 2D Control

To display the following slope settings for 2D applications (Figure 3-99 on page 3-91), press the **Slope Control Key**:

- Blade slope – the current percentage of slope for the slope sensor.
- Slope gain – displays the current valve gain setting for slope control. The valve gain setting determines the speed of the hydraulic valve response while in automatic control. A higher setting speeds up the response; a lower setting slows down the response.
- Survey – used to quickly lock the screed on-grade.
- Change to Elevation – used to switch to 2D elevation control.

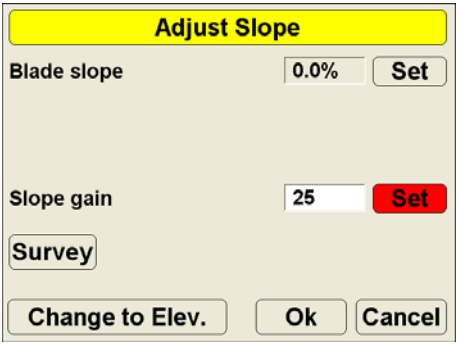


Figure 3-99. Adjust Slope Dialog Box – 2D Control

Setting the Slope Offset and Locking On-grade

1. Press the **Slope Control key**, then press the *Blade slope* **Set** key. Enter the slope offset using the pop-up keyboard or the up/down arrows (Figure 3-100).
2. Press **Survey** to quickly lock on-grade (Figure 3-100).
3. Press **Ok** to return to the Main Screen (Figure 3-100).

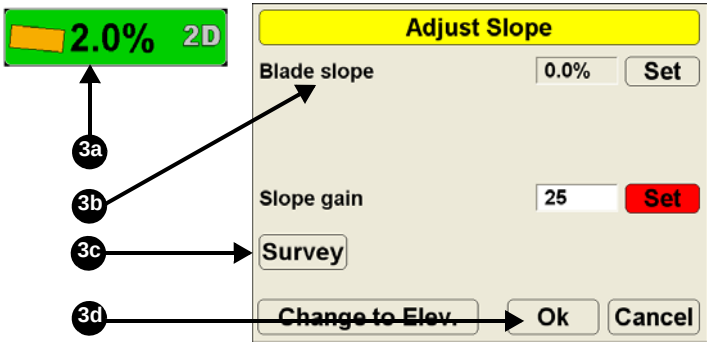


Figure 3-100. Survey On-grade – Slope Example

Pop-up Menu

The 3DMC pop-up menu provides quick access to elevation information and the steering or grading to polyline functions. Pop-up menu selections depend on active files or the selected object.

To access the pop-up menu, press anywhere on the 3DMC Main Screen (Figure 3-101).

- Design Elevation – displays the elevation of the point tapped on the Main Screen.
- Steer to Polyline – available for linework files; controls the machine, steering it along the selected polyline.
- Grade to Polyline – available for linework files with elevation information; controls the machine, paving along the selected polyline.

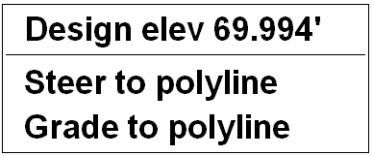


Figure 3-101. Pop-up Menu

Changing Control Methods

In 2D control applications, the ***Adjust elevation*** and ***Adjust slope*** dialog boxes can be used to change the control method to either slope or elevation.

To change the elevation side of the machine to slope, (Figure 3-86 on page 3-81)

1. Press the **Elevation Control key**.
2. Press **Change to Slope** to use the slope method for control.

Paving Principles

This chapter describes the components of pavers and the basics in paving principles.

Paver Components

Modern pavers (Figure 4-1) consist of two major units: the tractor and the screed.

The primary function of the tractor is to propel the truck or paver feeding device, to convey and distribute the paving material, and to tow the screed. The function of the screed is to strike off the material in preparation for further compaction. The screed is mounted to the tow arms at the screed pivot points and is attached to the paver at the tow points.

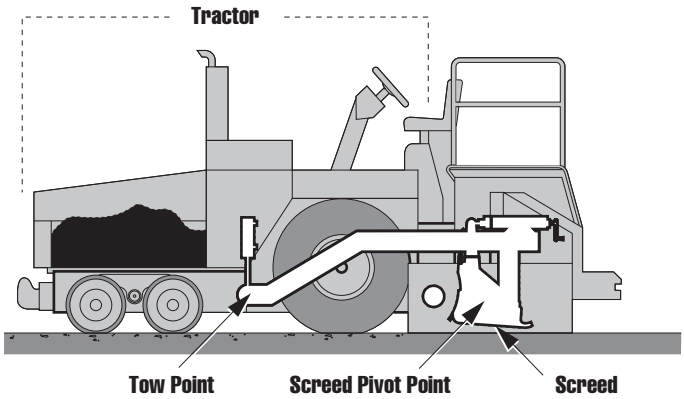


Figure 4-1. Paver Components

How a Screed Works

The screed on all modern pavers is of the “floating, self leveling” type. As the paver tows the screed unit forward, paving material flows under the screed. This causes the screed to float on the mat of material, thus establishing mat thickness. Since the screed is mounted to the paver only at the tow points, the screed is completely free to float up or down (Figure 4-2). The screed always seek it’s own “Planning Angle”, or angle of attack, dependent on the combination of forces acting upon the screed (Figure 4-2).

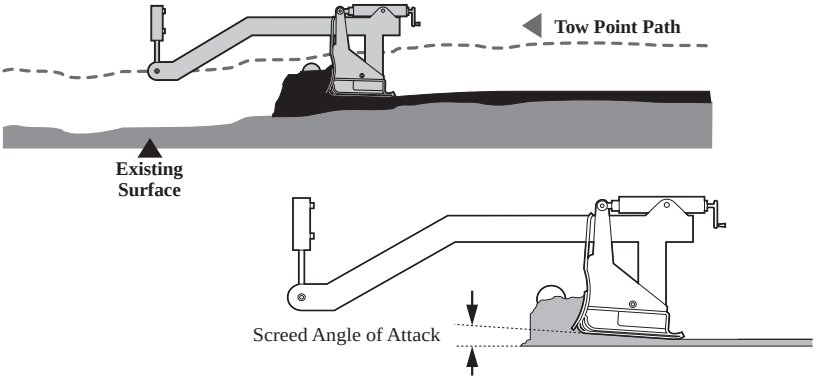


Figure 4-2. Tow Point Path and Planning Angle

- If the screed angle of attack is increased, the screed rises, increasing the mat thickness (Figure 4-3).
- If the screed angle of attack is decreased, the screed settles, providing a thinner mat surface (Figure 4-3).

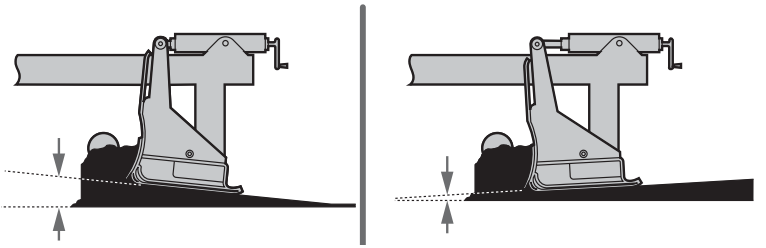


Figure 4-3. Screed Determines Mat Thickness

Because the screed floats, it does not immediately react to a change in the tow point. It needs a certain amount of time or distance to make a correction in the mat thickness (Figure 4-4).

- If the tow point is changed by a unit of one, the paver must move one tow arm length before the screed corrects 63% of the elevation.
- After 2 tow arm lengths 83% of the correction is made and 3 tow arm lengths would account for 95%.
- It takes 6 tow arm lengths to achieve 100% of the elevation change.

Considering that 95% of the change takes place after 3 tow arm lengths, this can be used in practical applications to qualify for full correction.

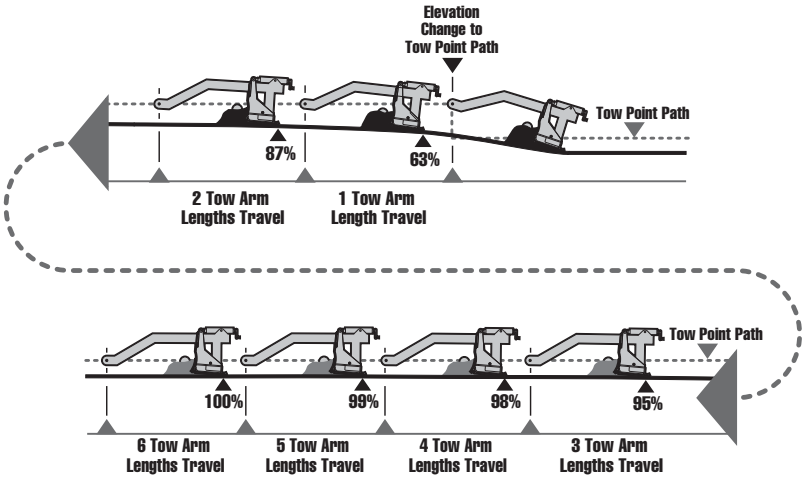


Figure 4-4. Tow Arm Travel

The same is true when making elevation changes with the manual thickness cranks (Figure 4-5).

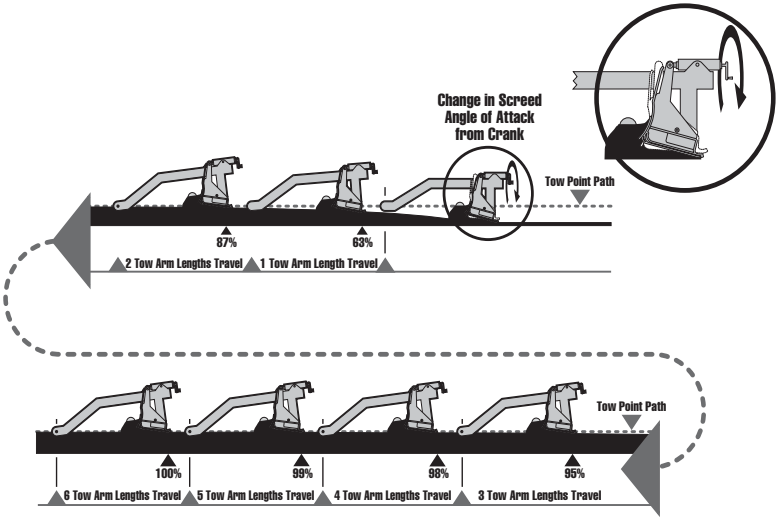


Figure 4-5. Manually Changing Mat Thickness

Always check mat depth in several locations before making any elevation corrections. The surface being paved may have wheel ruts, dips and ridges that give an untrue indication of overall mat depth. Check several spots to get an average (Figure 4-6). If an elevation change is made, wait 3 tow arm lengths for full correction. Too much cranking and stabbing causes raising and lowering changes that produces an uneven mat surface.

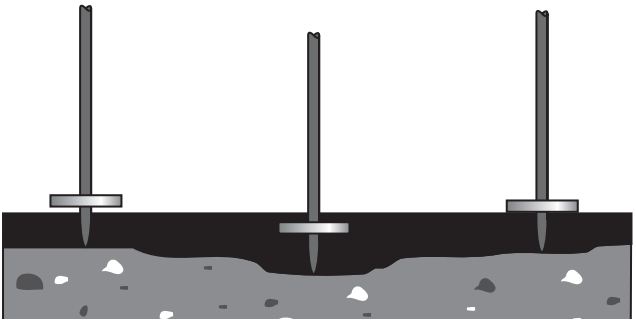


Figure 4-6. Checking Mat Thickness

The screed has four main forces acting on it at all times, whether paving in manual or with automatics (Figure 4-7). A change in any one of the forces causes the screed to rise or fall, changing the mat depth. The key to smoother paving is to keep these forces as constant as possible. The following sections review these forces and the factors that have an effect on the paving.

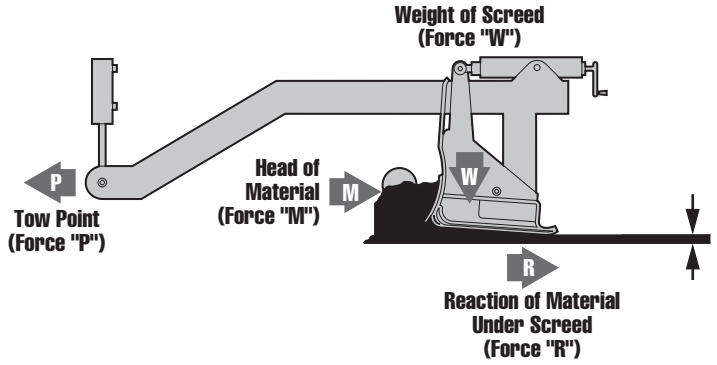


Figure 4-7. Forces Affecting the Screed

Tow Point Force (“P”)

The tow point force (P) is the resistance to forward travel (Figure 4-8).

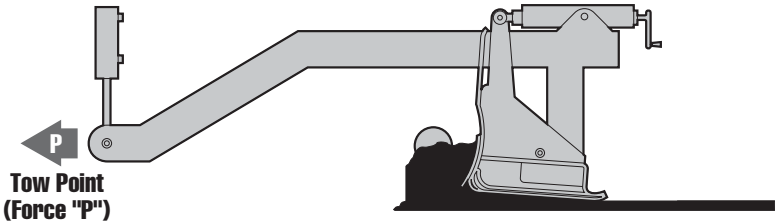


Figure 4-8. Tow Point Force (“P”)

The P force remains constant if the paver is kept moving at a consistent speed at all times. If the paver is allowed to stop, the screed settles in the fresh mat and leave a mark. The mark cannot be fully smoothed out by the roller and a bump ends up in the mat that shows up in the profilograph readings. Changing the speed of the paver also causes the screed to rise and fall, affecting the mat thickness.

The optimum paving speed is determined by the depth and width being paved and the rate at which material can be delivered to the job. Calculate the tons/hour into feet per minute (Figure 4-9). Do not start and stop the paver.

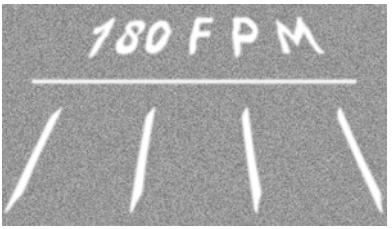


Figure 4-9. Travel Speed to Reduce Tow Point Force ("P")

Truck Exchange, Another Tow Point Force

It is very important that truck exchanges be carried out as smoothly as possible to avoid disturbing the smooth, uninterrupted forward motion of the paver. The following lists some steps to take to avoid disturbance of the paving operation by trucks.

1. Stop the mix delivery truck close, but not too short of the paver. Always allow the paver to pickup trucks on the run.
2. Never allow the truck to bump the paver. Allowing trucks to bump the paver when backing up, can drive the screed into the mat and produces bumps and ridges which may not roll out.
3. Trucks applying and holding their brakes excessively while dumping their load may cause the paver to slow, which in turn causes the screed to rise. The truck driver should apply only light pressure on the brakes, sufficient to maintain contact with the paver.
4. Dumping of material in front of the paver as the truck pulls away after emptying its load into the hopper, can cause the paver to ride over the pile of material with subsequent adverse effects on mat quality. Avoid trucks pulling away prior to completely dumping all material. Use a dump person to monitor and regulate truck movements in front of the paver.

Head of Material (“M”)

One of the primary functions of the paver tractor is to convey and distribute paving material onto the ground in front of the entire width of the screed. This material, once deposited in front of the screed is the head of material over which the screed passes.

One of the keys to smooth paving is to maintain this head of material as constant as is possible. The resistance to forward motion exerted by the head of material (M) is one of the major component of resistance to forward motion (Figure 4-10). Control of this force is a basic and necessary function of any paving operation.

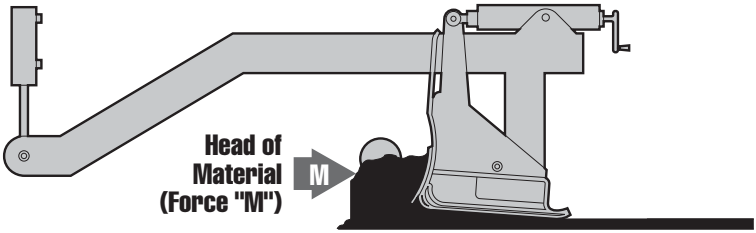


Figure 4-10. Head of Material Force (“M”)

The volume and consistency of the head of material determines how much paving material flows under the screed and influences mat thickness and surface texture.

The most common factor affecting force “M”, the head of material, is incorrectly adjusting the Automatic Feeder Controls.

These systems, whether of the “hanging paddle” type or the sonic sensor type, should be adjusted to operate the auger/conveyor assemblies 95% to 100% of the time. On/off operation of the auger system causes fluctuation in the head of material.

The highest quality mat is the general result when a constant head of material is maintained across the entire width of the screed and the material almost covers the auger shaft. If the volume of paving material is too high, there is resistance to the travel of the screed. This causes the screed to rise and can result in ripples, auger shadows and long waves. It also results in increased auger wear (Figure 4-11 on page 4-8).

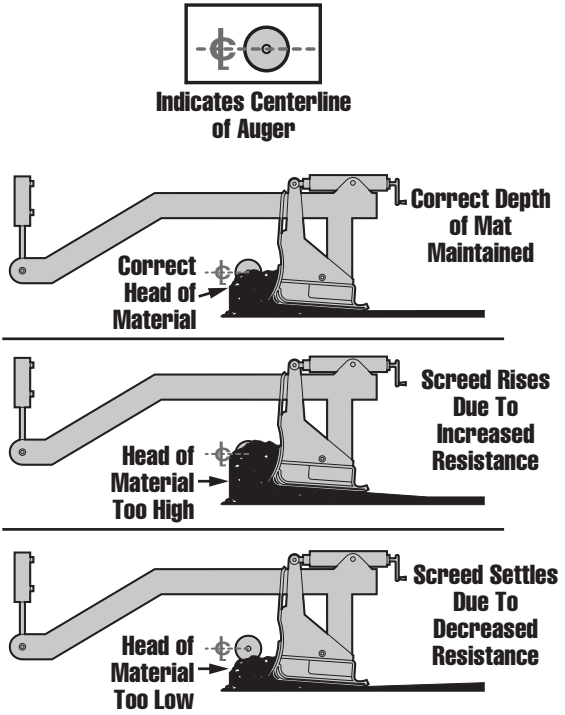


Figure 4-11. Head of Material Affects Mat

Reaction of Material Under Screed ("R")

Ideally, every truck load of material delivered to the paver would be exactly like every other load, with no variation. However, as a practical matter, changes in mix characteristics such as mix temperature, density, gradation, A.C. Content, and segregation, affects the internal stresses developed within the mix, which in turn affects the resistance of the mix to flow under the screed (reaction of material under screed, "R"). The key element to bear in mind is that the screed passing over the paving material compacts the material to a certain degree. Variables in the resistance of the material to compactive forces causes changes in the screed's angle of attack,

which in turn affects mat thickness and therefore, mat smoothness (Figure 4-12).

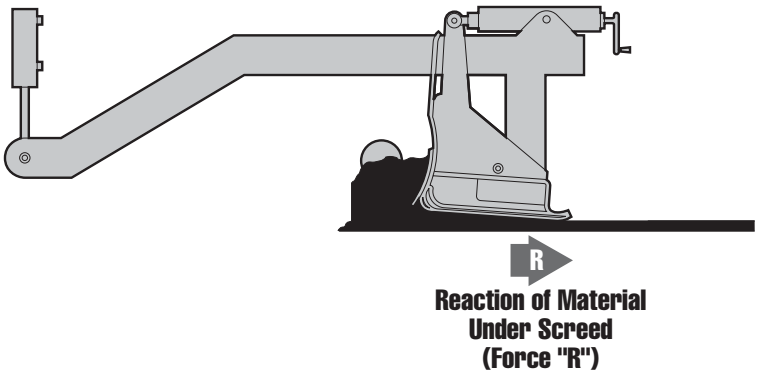


Figure 4-12. Reaction of Material Under Screed

Gradation Mix Characteristics

This aspect of the paving material varies according to the intended use of the material as a base course, binder course, or the final wearing surface. Normally, maximum aggregate size, ratio of aggregates, fines content and most importantly, asphaltic binder content, is specified by the contracting agency.

Adherence to mix design specifications is usually the responsibility of the material supplier.

Segregation is a material deficiency caused by a separation of the larger aggregate sizes from the bulk of the paving material.

This condition is encountered especially in mixes with relatively large maximum size aggregate (example: 1" and larger, the so called “large-particle” mixes). When paving material is deposited in piles, as in an asphalt plant silo, a haul truck, a paver hopper, on the ground in front of the paver in a windrow, or on the ground in the auger chamber, segregation can and does frequently occur.

The areas listed above where segregation can occur are all areas that the material may encounter before being laid down as a mat. Therefore, these areas of segregation must be addressed prior to any paving. The screed cannot rectify segregation during the paving process.

Segregation can also be the result of improper hopper dumping.

During normal operation, the vibration of the pavers hopper causes segregation. Therefore, dumping the hopper after each truck should be avoided because material that has rolled to the outside of the hopper (the large aggregate) fills the conveyors and auger chamber and result in a segregated area behind the paver with a noticeable difference in surface texture.

If It Doesn't Look Right, It Isn't Right Surface and texture irregularities indicate that the homogeneous characteristics of the material in the mat have been interrupted, which usually results in bumpiness and premature failure of the pavement in those areas.

Segregation can also be the result of excessively worn augers: "Center Streak" segregation can be caused by worn "Kicker Paddles" at the auger chain case or near the outside auger bearings. In fact center streak segregation is frequently caused by incorrect arrangement of the auger segments adjacent to the auger chain case. (Refer to the Manufacturer's Manual for details).

"Center Streak" segregation is also caused by feeder gates being set too low. Adjust as necessary to provide sufficient uniform material at the center of the paver.

"Center Streak" segregation can be limited and even eliminated by slowing paving speed.

Mix Temperature Characteristics

A common paving problem is inconsistent temperatures in the asphalt mix. As the material cools it loses its viscosity making it more difficult to compact. If the resistance to compaction increases, the screed naturally increases its angle of attack and begin to float up. This changes the mat depth, resulting in bumps in the surface. If the mix and/or screed temperature are too low, the screed may no longer slide smoothly over the material and a tearing of the mat occurs.

Simple steps to take to control temperature variations

1. Ensure that haul trucks take the shortest, most practical route to the paver. Make certain that all trucks take the same route to the paver.
2. Make sure that the trucks arrive at the same order in which they were loaded at the asphalt plant.
3. Ensure that no bunching of trucks occurs at the paver, with several trucks waiting to dump their loads.
4. Match lay-down rate to material delivery rate.

Temperature problems may occur before the time the material is loaded into the trucks, or during the trip to the paver. They can be the result of temperature variations at the plant. If this is not addressed prior to delivery of material to the machine, waviness in the mat is the result.

Weight of Screed (“W”)

For the weight of screed force “W” to remain constant, the weight of the screed or the downward pressure exerted by the screed on the paving material should not change (Figure 4-13). The weight of the screed is measured in pounds per square inch.

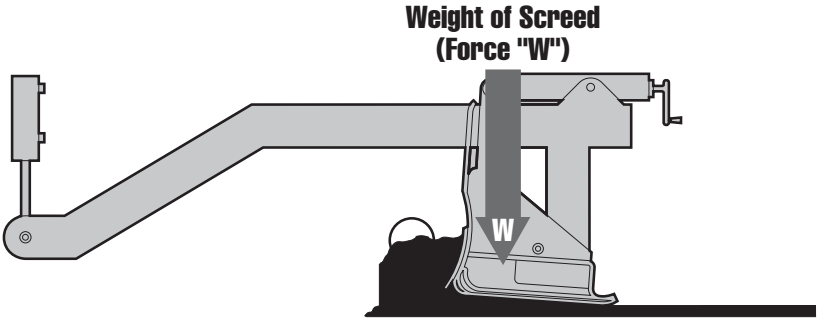


Figure 4-13. Weight of Screed

Members of the paving crew climbing on and off the screed also has some affect on the weight of screed force.

The primary factor affecting this force is changing the width of the screed (Figure 4-14). Extendible screeds weigh the same whether they are fully retracted or fully extended. The difference is the wider the extension of the screed the greater the surface area of paving material to support. An extended screed has fewer psi, which means less compaction, causing the screed to raise.

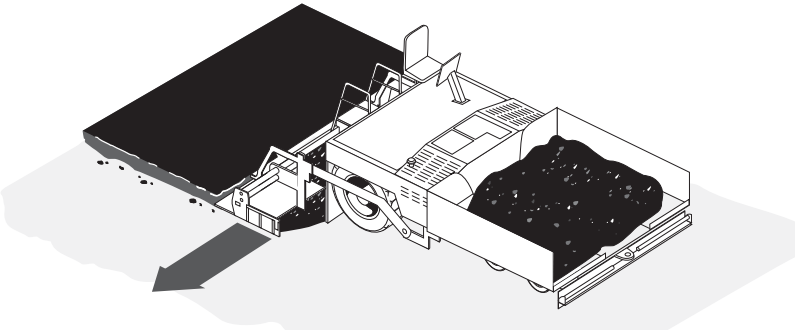


Figure 4-14. Width of Screed Affects Weight of Screed

Quality of Base Being Paved

There are factors other than the four main forces that can have an effect on the quality of the mat. An important one is the quality of the base to be paved. It makes more sense to build smoothness from the base up, than to try to smooth a road in the last lift of paving. However, on overlay paving jobs you have to work with what you have.

Remember that a mat which appears smooth immediately behind the paver, may actually contain areas of considerably varying thickness of material as a result of undulations in the base being paved. Due to the principle of "Differential Compaction", high spots do not compact as much as the low, allowing some of the irregularities to be rolled back onto the mat (Figure 4-15). To minimize this problem, lay a leveling course in the low spots or pave multiple lifts to average out the irregularities.

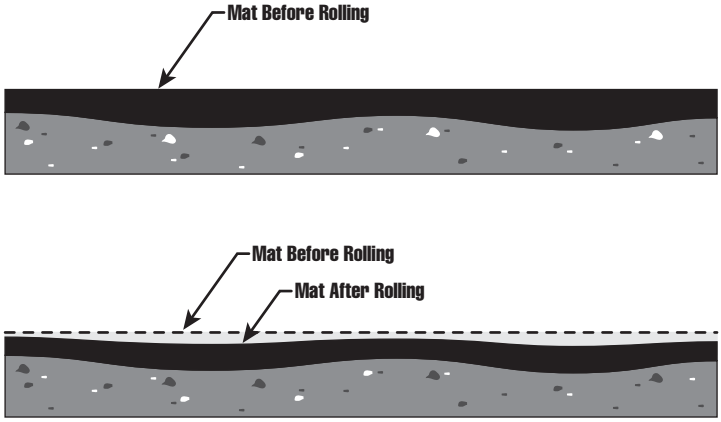


Figure 4-15. Differential Compaction

Rolling Techniques

A well laid mat ends up with a poor ride quality if proper rolling methods are not followed. Consult your compaction equipment manufacture's manuals and handbooks on compaction techniques.

Controlling Mat Quality

The primary purpose of the asphalt paver is to place a smooth mat of material. The primary function of mmGPS 3D Paver is to control the vertical position of the screed in relation to the surface being paved. Automatic grade and slope control systems helps tremendously in controlling mat smoothness but mat quality is also dependent on the following factors:

- Non-stop, continuous operation of paver
- Constant speed of paver
- Truck exchange
- Head of material
- Mix characteristics
  - – Gradation
  - – Segregation
  - – Mix Temperature
- Screed Compaction
- Quality of Base Being Paved
- Rolling Techniques

Changes in any of these factors causes a change in mat thickness, density, surface appearance, and mat quality. If changes must be made, make them as gradually as possible. Abrupt changes in any of the above factors produces rapid changes in mat thickness, adversely affecting mat quality.

Getting Started

Millimeter GPS (mmGPS) combines the elevation accuracy of a laser with the horizontal and vertical accuracy of GPS+ receivers to provide millimeter accuracy while paving or surveying. The system provides multiple rover support for machine and pole mounted sensors.

See “Control Methods” on page 5-23 for a discussion on placing transmitters around the jobsite and for using up to four transmitters.

mmGPS applications require both a GPS Base Station and a Base Transmitter: the first to transmit GPS corrections and the second to transmit a laser plane. An optional Rover surveying setup provides a GPS receiver/radio and a laser sensor in one package for various site checking activities.

This chapter is designed to get the paving crew started using the mmGPS 3D Paver system. The job application and the actual results determines what type of controls should be used; that is, mmGPS, sonic, slope, or laser.

- For mmGPS setup, first set up the PZL-1 laser transmitter over a control point, then the PZS-1 sensor on a range pole, then install the PZS-MC sensor on the machine with a MC-2.5 receiver.
- For Sonic Tracker II™ setup, attach the sonic trackers, then setup the control box. See “Using Sonic Control at the Jobsite” on page 6-1 for details.
- For laser tracker setup, first setup the laser transmitter, attach the laser tracker to the machine, then setup the control box.
- For slope sensor setup, first attach and power up the control box, then check the sensor’s calibration to ensure correct grade.

Equipment Setup and Initialization: Base Station

The Base Station always sets up over a Control Point on the jobsite; to ensure accuracy, the Base Station GPS+ antenna must be positioned directly over the top of the Control Point.

The Base Station can be set up and taken down on a daily basis, or can be mounted on a permanently fixed pole and left for the duration of the project. A permanent setup prevents errors due to incorrect antenna height measurements.

When setting up the Base station, make sure you select the correct point from the control points file and verify the point has a northing, easting, and elevation coordinate. The more accurate these coordinates are, the tighter the control while paving.

Use the following checklist for quick setup of the Base Station.

- ☐ Select a control point and install the Base station over it.
- ☐ Measure the antenna height.
- ☐ Connect all Base Station components and cables.
- ☐ Select the correct radio settings. Refer to your Base Station's documentation for specific radio configuration procedures.

  The Base and Machine must use the same radio settings.
- ☐ Initialize the Base station.

Once you have set up the Base Station, simple checks at the machine ensure the machine receives corrections from the Base station: if the elevation control key is green, the Base Station is ready.

See "Setting up the Jobsite and Pocket-3D" on page 2-1 for more information on using Pocket-3D to set up the jobsite using for mmGPS-3D Paver.

Equipment Setup and Calibration: PZL-1Transmitter

For machine control applications, the PZL-1 transmitter attaches to either a standard tripod or a fixed 2m tripod over a surveyed point. To locate the transmitter over an unknown point, see “Performing a Resection” on page 2-28.

The following setup requires Pocket-3D to activate and initialize the transmitter. For more information on the Pocket-3D software, refer to the *Pocket-3D User’s Manual* and *Pocket-3D Reference Manual*.

1. Locate a control point over which to set up the PZL-1 laser transmitter.

See page 2-4 for detailed notes on how to setup and level a tripod.

2. Attach the transmitter to the tripod.
3. Turn on the transmitter’s power and select a channel for the transmitter (Figure 5-1 on page 5-4).

   To assign a channel to the transmitter, press the channel button until the corresponding LED lights up.
4. Connect the transmitter and Pocket-3D controller (Figure 5-1 on page 5-4).

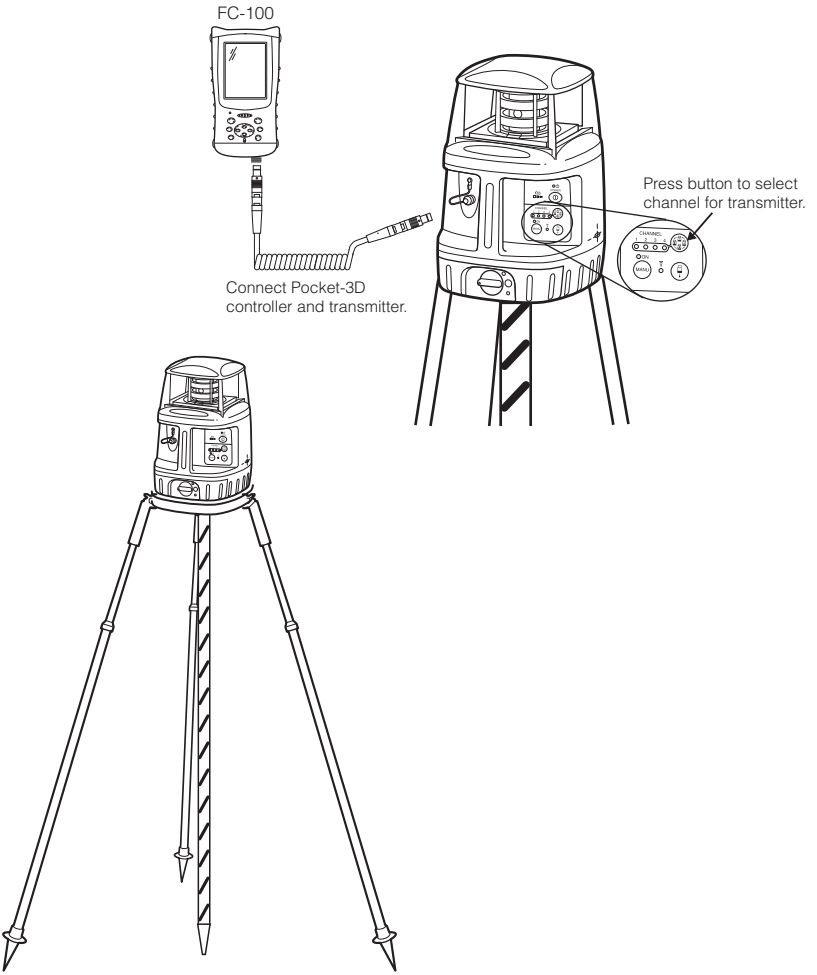


Figure 5-1. Setup PZL-1 Laser Transmitter, Select Channel, and Connect Controller

5. In Pocket-3D, check that a mmGPS-enabled machine configuration is loaded. Then tap **Setup ▸ mmGPS Transmitters** to set up from one to four transmitters.

6. On the *Transmitters* tab, select the connection method used between the controller and transmitter. Then perform one of the following functions (Figure 5-2):
   - **To load transmitter data for the first time** – tap **Download** to retrieve calibration data from the connected transmitter. The download is complete when the firmware version displays in the *Firmware* column.
   - **To add a \transmitter** – tap **Add** and enter a transmitter serial number or other description.
   - **To delete a transmitter** – select a transmitter and tap **Delete**.
   - **To calibrate the transmitter** – see "Transmitter Adjustment" on page 2-32.

   Once the *Transmitters* tab contains a list of transmitters, each transmitter must be set up on a unique channel. The channel button on the transmitter determines the channel that the transmitter broadcasts on.

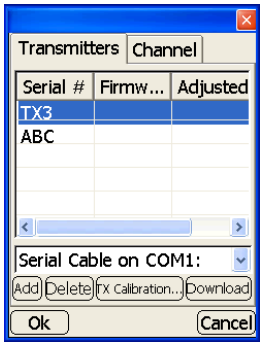


Figure 5-2. Load Transmitters into Pocket-3D

7. To enter transmitter setup information, tap the *Channel* tab and select the connected transmitter, then press **Edit Channel**. Set the following parameters and tap **Ok** (Figure 5-3 on page 5-6):
   - Transmitter – select the ID of the transmitter
   - Control Point – select the control point over which the transmitter is set up
   - TX height – enter the height of the transmitter

- Measured to – select where on the transmitter (Base or Mark/ Slant) the height was measured

8. If needed, repeat steps 6 and 7 for up to three other transmitters.
9. Press **OK** when done.

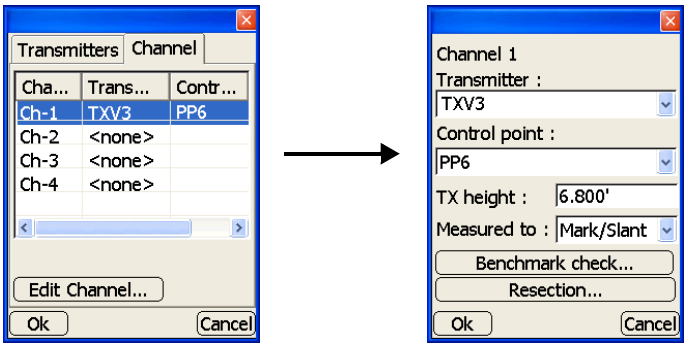


Figure 5-3. Enter Transmitter Channel and Control Point Data

Equipment Setup: Machine Components

After setting up the Base Station and PZL-1 transmitter, set up the following machine components.

☐ Attach the PZS-MC Sensor to the GPS Vibration Pole.

☐ Attach the MC-2.5 Receiver Box to the machine and connect the cables.

☐ Connect the Control Box to the machine and connect the cables.

☐ Accurately measure the PZS-MC Sensor on the machine.

☐ Set up 3DMC for the machine and jobsite.

☐ Select the PZL-1 Transmitter for the jobsite.

PZS-MC Setup

After mounting the PZS-MC receiver to the vibration pole, use 3DMC to configure the receiver for the machine. Figure 5-7 on page 5-11 shows the mounting and cable connections for the PZS-MC receiver.

The PZS-MC receiver has the following setup requirements:

- Face the receiver's logo and LEDs forward; face the connectors towards the machine.
- Connect the right-angle end of the serial cable to the PZS-MC receiver.

1. With the screed placed on level ground, position the GPS vibration pole vertically.
2. Attach the PZS-MC receiver to the pole and position it with the LEDs facing forward (Figure 5-4 on page 5-8). Tighten the hand knob.
3. Connect the cables to the receiver and then to the MC-2.5 Receiver Box.
   - antenna cable to the connector on the left
   - serial cable to the connector on the right

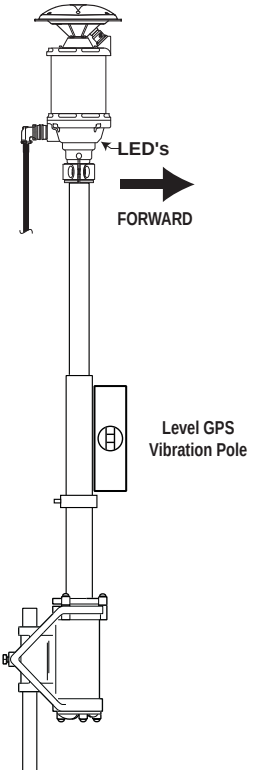


Figure 5-4. Level the GPS Vibration Pole and Attach the PZS-MC Sensor

Screed and Antenna Measurements

Take the following measurements for the antenna and machine; record these measurements for entering into 3DMC (Figure 5-5):

- Above (1) – enter the vertical distance from the metal rim of the antenna to the bottom edge of the screed (when elevated to the proper mat thickness).
- Inside (2) – enter the horizontal distance from the metal rim of the antenna to the outer edge of the screed.
- Behind (3) – enter the horizontal distance from the metal rim of the antenna to the back edge of the screed.
- Width (4) – enter the horizontal distance from the left edge to the right edge of the screed.

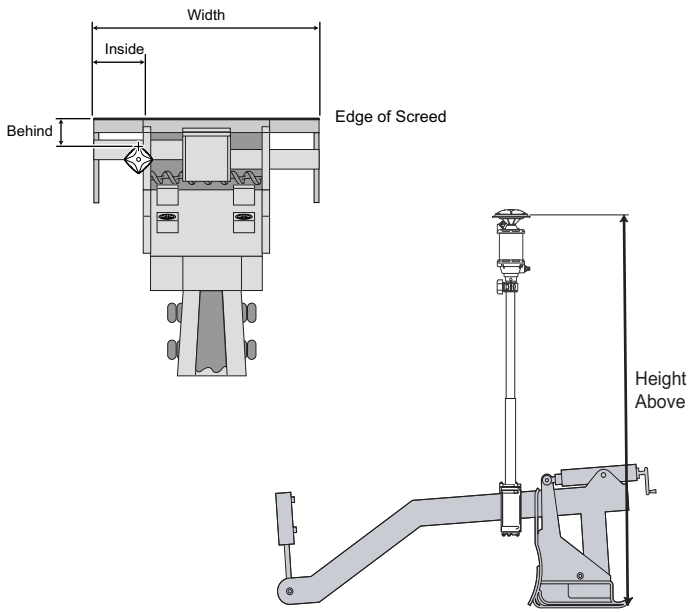


Figure 5-5. Measure Antenna Placement on Screed

NOTICE

Incorrect measurements or data entry errors have a direct affect on paving accuracy.

Take each measurement twice to ensure accuracy.

Radio Antenna Installation

The radio antenna is attached on the machine using a magnetic mount, and generally stays on the machine. The antenna should be positioned vertically and as high as possible on the machine to maximize signal reception (Figure 5-6).

1. Attach the radio antenna to the roof of the machine.
2. Connect the radio antenna cable.

When the system has not been used for several days or months, the antenna might have been removed for storage or transportation. To reinstall the radio antenna, set it up as described above and ensure the magnet mount attaches to an even and smooth surface.

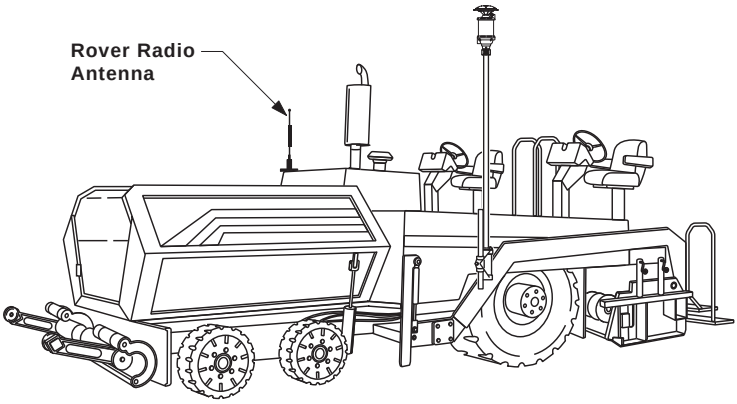


Figure 5-6. Machine Radio Antenna Setup

MC-2.5 Receiver Box Setup for mmGPS Applications

The MC-2.5 Receiver Box is designed for quick attachment at the beginning of the day and quick removal at the end of the day. When connecting cables to the receiver box (Figure 5-7), ensure that the cables do not impede machine operation.

1. If needed, attach the MC-2.5 Receiver Box to a convenient location on the machine.
2. Connect the PZS-MC Sensor antenna cable to the MAIN GPS port.
3. Connect the PZS-MC Sensor serial cable to the MAIN C port.
4. Connect the radio antenna cable to the RADIO ANTENNA port.
5. Connect the control box cable to the MAIN A port.

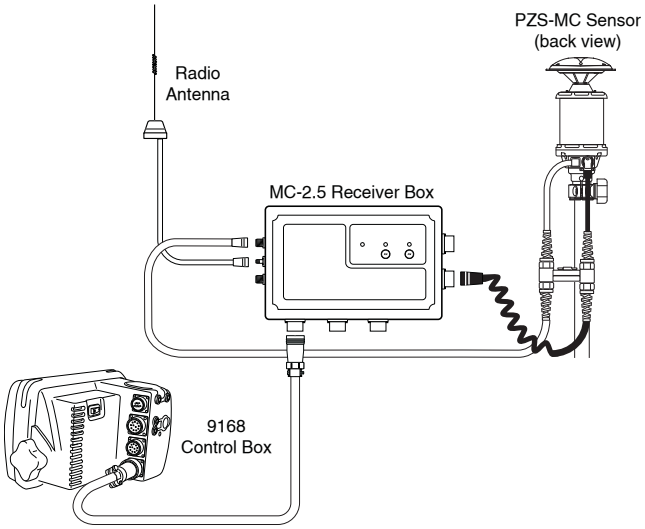


Figure 5-7. Connect Cables to MC-2.5 Receiver Box and 9168 Control Box

Control Box Setup

The 9168 control box is designed for quick attachment at the beginning of the day and quick removal at the end of the day.

1. Use the hand knob to attach the control box to the machine (Figure 5-8).
2. Connect the various electrical cables (Figure 5-8).

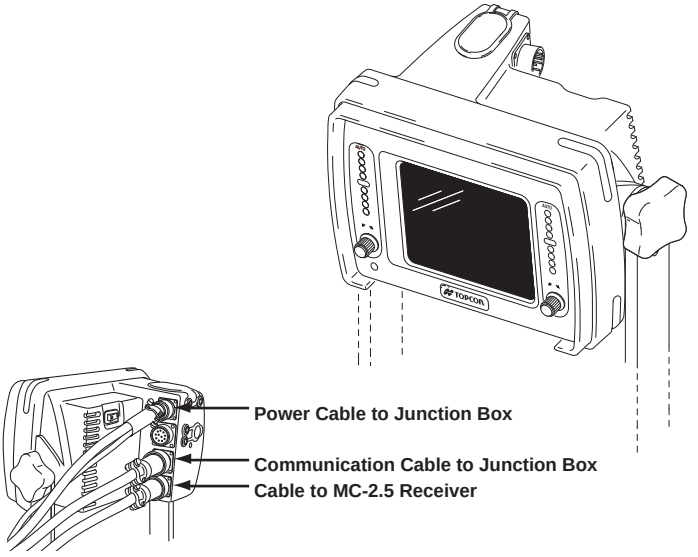


Figure 5-8. Attach 9168 Control Box to Machine and Component Cables

3DMC Setup

Once the hardware components are set up, installed, and connected, apply 3DMC machine and job files. Chapter 2 describes in more detail the items in the following checklist.

☐ Select the correct Machine Configuration file.

Topcon Logo ▸ Control ▸ Machine setup

☐ Select the Control Point file.

Topcon Logo ▸ File ▸ Control

☐ Select the Working and/or Reference Surface files.

Topcon Logo ▸ File ▸ Surfaces ▸ Working

Topcon Logo ▸ File ▸ Surfaces ▸ Reference

☐ As needed, select the Alignment file.

Topcon Logo ▸ File ▸ Alignment

☐ As needed, select the Linework file.

Topcon Logo ▸ File ▸ Linework

☐ Select the Points file.

Topcon Logo ▸ File ▸ Points

After selecting the information to view on the Main Screen, begin paving. See Chapter 3 for details on the different data and screen views available.

Setting up the PZL-1Transmitter in 3DMC

PZL-1 Transmitter information is saved in the control point file. Ensure the correct control point file is selected for the jobsite.

1. Press **Topcon Logo ▸ Control ▸ PZL-1 transmitters**.
2. Tap the channel tab that corresponds to the channel at the transmitter (Figure 5-9).
3. Enter the following information and press **Ok** (Figure 5-9).
   - Select the serial number of the transmitter on this channel.
   - Select the control point over which the transmitter is installed.
   - Enter the height of the transmitter.
   - Select the method used to measure the height of the transmitter.

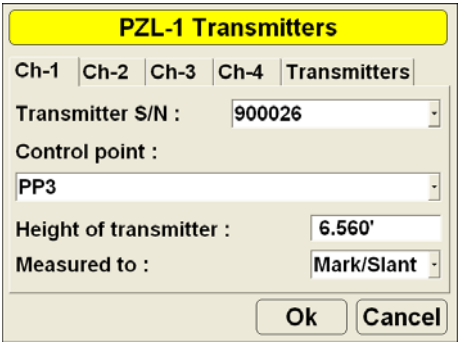


Figure 5-9. Set up PZL-1 Laser Transmitter in 3DMC

Machine Sensor Calibrations

Calibrating machine components ensures accurate, consistent, and efficient paving. Operators or technicians perform calibrations in the following instances:

- Upon initial installation of machine components.
- After servicing the system, performing maintenance, or replacing a component.
- When the machine no longer paves the correct cross-slope.
- After installing a PZS-MC sensor antenna on the machine.

Calibrating the Sensors Using the Slope Control Key

Sensor calibration calibrates the slope control system of the machine's screed. The sensor attached to the machine also needs to be calibrated. The sensor is attached to moving parts that wear at different rates. In order for the system to work correctly, it has to be "told" what changes have occurred on the machine. The control box saves calibration settings in its memory until the operator or technician changes them.

Pavers require only one sensor to control cross slope. This sensor must be calibrated to accurately measure the slope of the screed.

1. At the control box, press the **Slope Control Key**.
2. Place a precision carpenter's level along the bottom of the screed. Then manually tilt the screed until it is level.
3. Once the screed is dead level, press the Blade slope **Set** key to adjust the slope (Figure 5-10 on page 5-16).
4. Enter 0.0 and press **OK**. The Blade slope value displays as 0.0% on the ***Adjust Slope*** dialog box (Figure 5-10 on page 5-16).

5. Press **OK** to apply the new calibration. Press **Cancel** to use the previous calibrations.

If you have an instrument that can accurately measure the slope of the screed, simply press the Set key and enter the actual slope into the Blade Slope window.

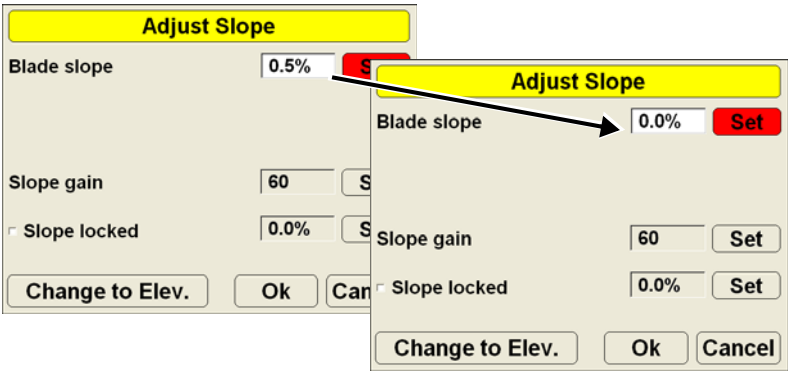


Figure 5-10. Adjust Slope

Setting the Valve Offsets

The valve offset calibration determines the minimum electrical signal required to begin moving the machine's hydraulic cylinder to return the screed to on-grade. Valve offsets simply determines the electrical requirement, valve gain determines the speed of the cylinder.

The system requires four valve offsets, which must be individually calibrated upon initial setup or after hydraulic maintenance. If valve offsets are set too low, the screed will not reach on-grade. Likewise, if the valve offsets are set too high, the screed moves too far and overshoot on-grade.

Factory preset for valve offsets: 0

NOTICE

Perform valve offset calibrations before adjusting elevation and slope valve gains. If valve offset is altered, valve gain adjustments need to be performed again.

NOTICE

When using the control box on different machines, perform valve offset calibrations and valve gain adjustments for each machine.

1. Raise the screed so that both sides rest a few inches above the ground.
2. At the control box, tap **Topcon Logo ▸ Control ▸ Valve offsets**.
3. Press the *Raise left* **Set** button to enable the entry box and calibrate the left valve offset value (Figure 5-11).

   The control box begins sending a raise signal to the left valve and the grade indicators display the currently active offset.

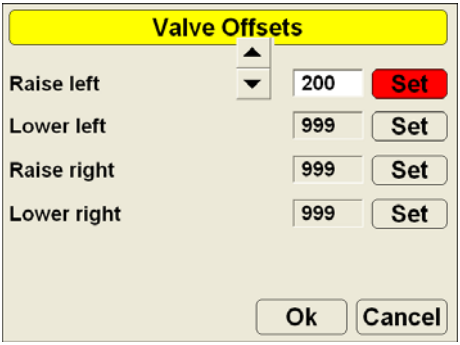


Figure 5-11. Begin Valve Offset

TIP

If the screed is moving, turn the Grade Adjustment Knob counterclockwise until the screed stops.

4. Slowly turn the Grade Adjustment Knob clockwise until the screed just begins moving (Figure 5-12 on page 5-18).
   - Turning clockwise increases the valve offset value.

- Turning counterclockwise decreases the valve offset value.

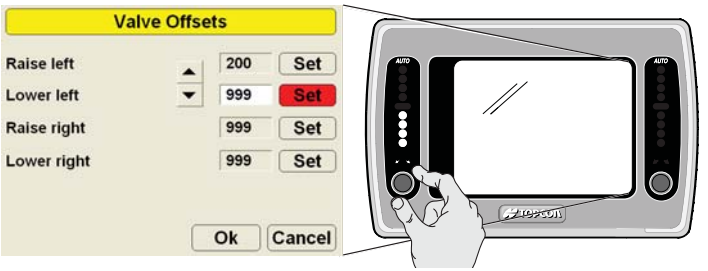


Figure 5-12. Setting Valve Offset Values

5. Press the **Set** key for each of the remaining selections, repeating step 3 and step 4 on page 5-17 until all four valve offsets are complete.
6. Press **OK** to store the calibrations.

NOTICE

You must press Ok to save and store valve offsets; otherwise, automatic control will not work correctly.

GPS Localization

After you have setup all the hardware components and initialized the Base Station, you need to localize the GPS coordinates to the jobsite's coordinates. This section gives information on the principles of GPS localization and entering GPS localization, into the Control Box.

Principles of GPS Localization

The GPS+ system is capable of precise positioning, but the positions it computes are relative to a global reference system defined in terms of a geographic latitude, longitude and height above (a representation of) the earth's surface.

To be useful for local site work, global GPS coordinates need to be converted into local site coordinates, defined in terms of a distance north and east of some origin point and some distance above an elevation datum. These north, east, and elevation coordinates (often

abbreviated to NEZ coordinates) may be those of a regional coordinates system—for example, a state plane system in the United States—or the project's survey crew may arbitrarily define these coordinates for the specific site; NEZ coordinates must be defined in terms of the construction design data. In either case, a mathematical conversion is necessary to turn global GPS coordinates into NEZ coordinates relative to a locally defined coordinate system.

The basic approach to calculating the mathematical conversion is to provide pairs of point coordinates for each Control Point on the project. A point pair consists of the following coordinates:

- (a) local NEZ coordinates for the point (obtained from the project's survey crew).
- (b) global latitude, longitude, and height coordinates for the point (measured as described in this section or obtained from the project's survey crew).

These pairs of points are needed to calculate a precise mathematical conversion formula for converting all global GPS coordinates generated in the MC-2.5 Receiver Box to local NEZ coordinates for a particular project.

The following steps help to ensure a high-quality localization suitable for centimeter-level machine paving with mmGPS 3D Paver.

- First, the surveyor's local Control Points must be precisely measured. The quality of measurements directly affects paving accuracy.
- Second, the Control Points need to be located more or less evenly around the site. Generally, the more Control Points the better, but if they are clustered together or are all at one section of the site, then the results are less than ideal.

  Locate Control Points evenly distributed around a perimeter of the site or paving area. While not directly related to the quality of localization, locate Control Points that are elevated, easily accessible, and not obstructed by trees, buildings, other structures, moving vehicles, and so forth.
- Third, GPS localization requires a minimum of three Control Points, but at least four or more points should be used for the localization.

GPS localization is processed in the control point file created prior to beginning each project. This control point file contains the formula necessary for the mathematical conversion between global GPS coordinates and NEZ coordinates. A control point file can be localized using one of the following methods:

- Measuring each control point with a Topcon GPS+ or GPS RTK Survey Rover System and Pocket-3D. Then entering this information into 3DMC.

  See “Localizing with Pocket-3D” on page 2-24 for this procedure.
- Entering global GPS coordinates directly into 3DMC.

  See “Entering Localized GPS Coordinates” below for this procedure.

Entering Localized GPS Coordinates

GPS localization is processed in the control point file created prior to beginning each project. This control point file contains the formula necessary for the mathematical conversion between global GPS coordinates and NEZ coordinates. The control point file can be localized by entering global GPS coordinates directly into the 9168 control box. One of the following sources can measure points and provide coordinates:

- Each control point is measured with a Topcon GPS+ or GPS RTK Survey Rover System and Pocket-3D.
- A third party source provides GPS coordinates.

If the control point file in 3DMC needs to be updated with localized coordinates, the operator can enter global GPS coordinates directly into the 9168 control box. The control box then processes the localization as the operator sits in the cab.

Because this method deals with control point files, see “Creating a Control Point File” on page 3-15 for further information.

1. Power on the control box and allow the 3DMC application program start up. Have the measurements for each Control Point available.

2. Press **Topcon Logo ▸ File ▸ Control**. The ***Control point files*** dialog box displays (Figure 5-13).
3. Select the correct control points file, and press **Edit**. The ***Control points*** dialog box displays, listing all control points for the file and jobsite (Figure 5-13).
4. Select a control point and press **Edit**, the ***Control points*** dialog box displays. This control point file should already have local site coordinates from the selected control point file (Figure 5-14 on page 5-22).

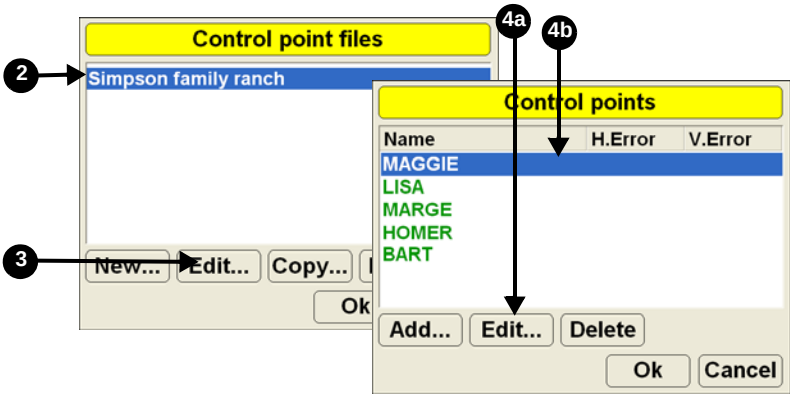


Figure 5-13. Control Point Files Dialog Box

5. Tap in each WGS84 coordinate entry box to display the numeric pop-up keyboard and enter the coordinates for latitude (Lat), longitude (Lon) and height (Hgt) (Figure 5-14 on page 5-22).
6. Tap the two GPS localization check boxes to enable (check) them for performing the GPS localization mathematical conversion (Figure 5-14 on page 5-22).

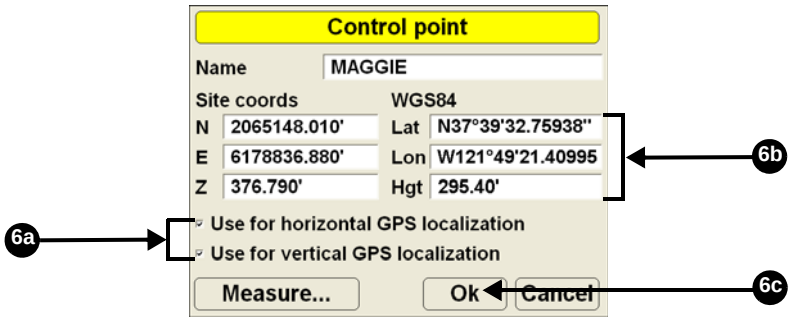


Figure 5-14. Control Point Coordinates and GPS Localization

7. Press **Ok** to return to the ***Control point files*** dialog box.
8. Repeat step 4 on page 5-21 and step 7 above for all listed control points. When finished, check the horizontal (H.Error) and vertical (V.Error) values listed on the ***Control points*** dialog box. They should be within acceptable tolerances (Figure 5-15).

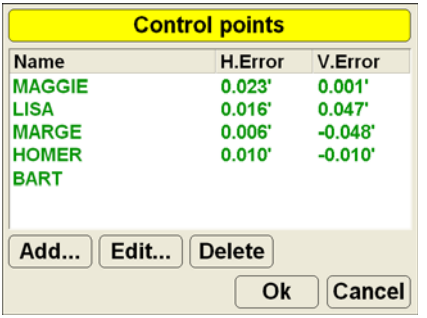


Figure 5-15. Control Point Files with GPS Localization

9. Press **Ok** until you return to the 3DMC main screen, saving the control point localization information and the control points file.

At this time, make a backup copy of the control point file on a CF card.

Control Methods

The following sections describe the four types of control possible with the mmGPS 3D Paver: mmGPS, slope, sonic, and laser.

mmGPS Control

mmGPS uses Topcon's unique LazerZone™ technology to produce millimeter accuracy. LazerZone technology combines the simplicity of a rotating laser, the accuracy of a robotic total station, and the flexibility and multiple-user capabilities of GPS into one complete jobsite solution (Figure 5-16).

- The PZL-1 laser transmitter emits a unique laser beam that provides a working range up to 2000ft (600m).
- The PZS-MC laser sensor and GPS receiver at the machine detects the laser beam and satellite signals, sending millimeter accurate positioning data to the control box for correction control.
- The PZS-1 sensor and GPS receiver detects the laser beam and satellite signals, providing millimeter accurate spot-checks throughout the jobsite.

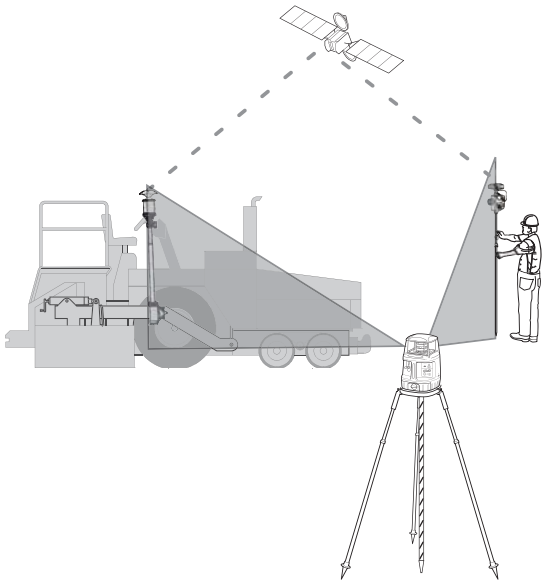


Figure 5-16. mmGPS 3D Paver at the Jobsite

Placing Transmitters at the Jobsite

The physical location of the laser transmitter on the jobsite should be outside the actual paving area, if possible. When choosing a location to place the laser transmitter, remember the following two recommendations.

1. Minimize the working distance from the laser transmitter.

   As the distance from the laser transmitter increases, paving accuracy decreases. The following factors affect paving at long distances:

   - Ground vibration from machinery working near the laser transmitter
   - Calibration error
   - Laser movement from blowing wind
   - Atmospheric conditions

2. Keep the laser transmitter as low as possible.

   Keeping the laser transmitter low, where you can reach it, will make setup and occasional adjustments easier. The transmitter and laser receiver on the machine will also be more stable. On windy days, you may need to anchor the tripod to keep the laser transmitter from moving.

   The laser transmitter does not need to be above the machinery on the job. The benefits of keeping it low, as well as GPS capabilities, far outweigh the momentary loss of the laser beam due to passing equipment.

   On small projects, place the laser transmitter off the working area (Figure 5-17 on page 5-25). The working distance from your laser will indicate the type of project (small or large).

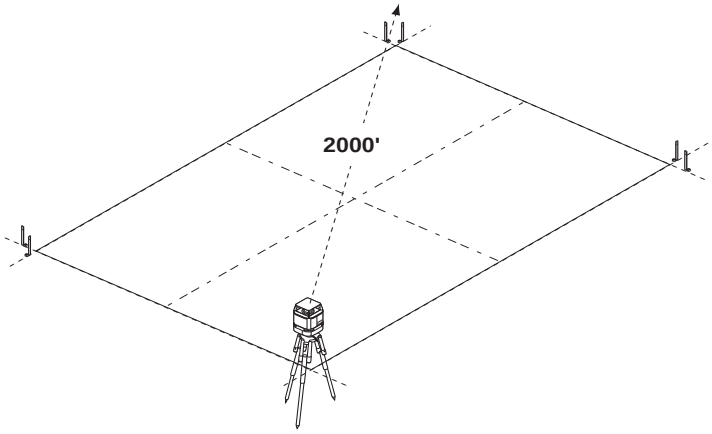


Figure 5-17. Laser Transmitter Placement – Small Project

On larger projects, place the laser transmitter in the center of the project to maximize the area you can pave and minimize the distance from the laser (Figure 5-18).

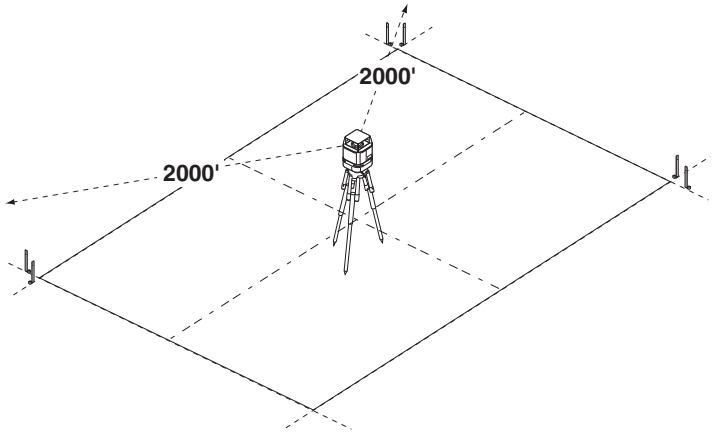


Figure 5-18. Laser Transmitter Placement – Larger Project

For particularly large projects, you can use up to four PZL-1 laser transmitters to increase the working range of the sensors.

Using Multiple Transmitters

Up to four PZL-1 laser transmitters can be used for a single job, increasing the range of the sensors to cover nearly 8000ft (2438m) in distance or up to 130ft (40m) of elevation changes. When using multiple transmitters, you will use 3DMC and the Pocket-3D hand-held controller to configure the PZS-MC and PSZ-1 for detecting each transmitter.

When using multiple transmitters, place each transmitter so that its beam will partially intersect the beam of its neighbor transmitter (Figure 5-19). The PZL-1 laser transmitters can be placed on either level or hilly ground.

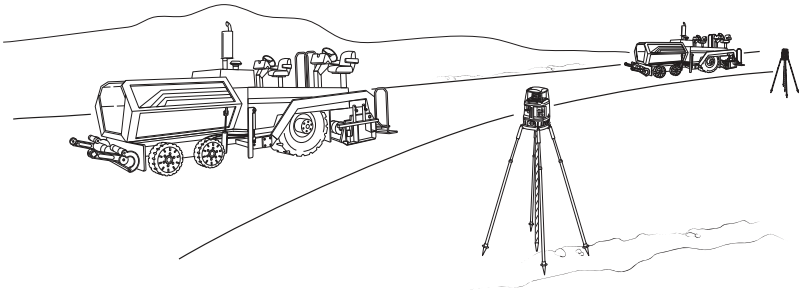


Figure 5-19. Multiple Laser Transmitter Placement

Slope Control

mmGPS 3D Paver uses a slope sensor mounted to the transducer beam on the paver to measure and control the slope of the mat being laid (Figure 5-20 on page 5-27). The sensor contains an electronic level vial, that acts as a “precision carpenter’s level”. Slope control with this electronic level vial is very accurate and repeatable.

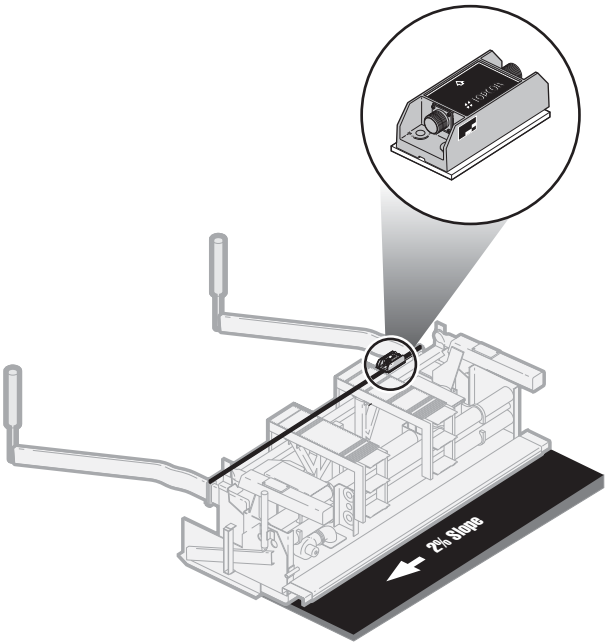


Figure 5-20. Position of Slope Control on Paving System

If the slope changes, or to make required slope changes, do the following:

- If the required slope changes, (while in automatic mode) the two point cylinder on the slope side will raise or lower until the slope sensor measures the new slope (Figure 5-21 on page 5-28).
- The slope may be changed manually with the grade adjustment knobs if the Slope locked box has been enabled on the Adjust Slope screen (see “Adjust Elevation in mmGPS Control” on page 3-78).
- The slope may be adjusted at any time while in 2D mode using the grade adjustment knobs.

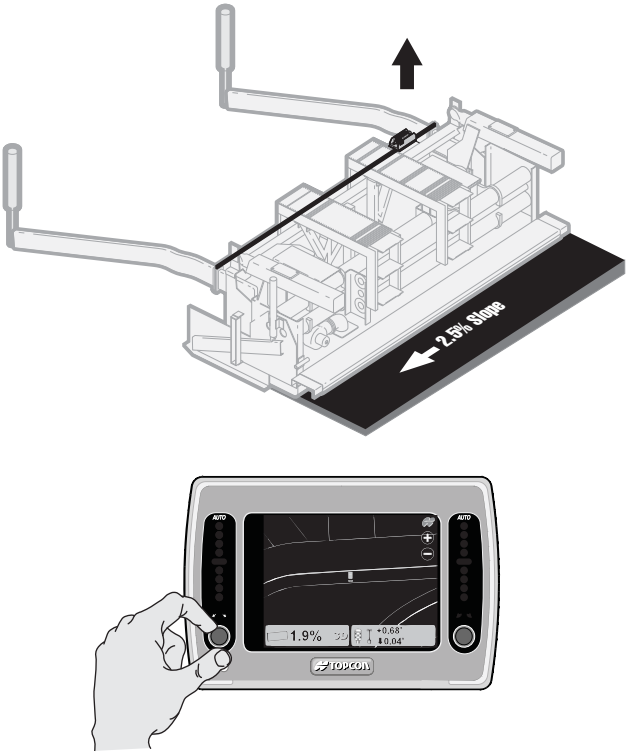


Figure 5-21. 9168 Control Box Directing Where the Slope Sensor Paves

Sonic Control

The Sonic Tracker II™ measures and controls the elevation of the machine, controlling grade from a physical grade reference, such as a curb, stringline, or existing road surface.

The Sonic Tracker II sends out sound pulses 39 times per second. As soon as the Tracker sends out a sound wave, it starts a stop watch. The sound waves go down, bounce off of a physical reference, and reflect back to the Tracker. The Tracker measures the time it takes for the sound wave to return to the Tracker. Knowing the speed of sound, the Tracker accurately calculates the exact distance to the grade reference (Figure 5-22).

- When the Tracker is on-grade, the cutting drum is at the desired depth.
- If the cutting drum and Tracker start to raise, the Tracker and control box indicate a down correction arrow, and the lower hydraulic valve corrections bring the Tracker back on-grade.
- If the cutting drum and Tracker start to lower, the Tracker and control box indicate a raise correction arrow, and the raise hydraulic valve corrections bring the Tracker back on-grade.

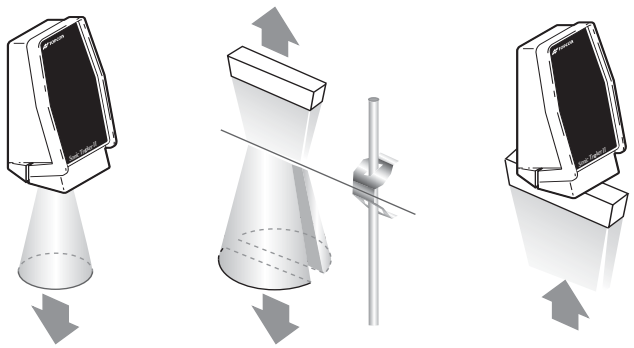


Figure 5-22. Sonic Tracker II Control

See Chapter 6 for more details about using a sonic sensor as the control method at the jobsite.

Laser Control

For Laser Control, a laser transmitter is used to produce a plane of light which becomes the grade control reference for the jobsite. The laser receiver will control the screed to lay a mat parallel to the laser beam reference.

When the laser beam is in the center of the receiver, it indicates an on-grade signal (Figure 5-23).

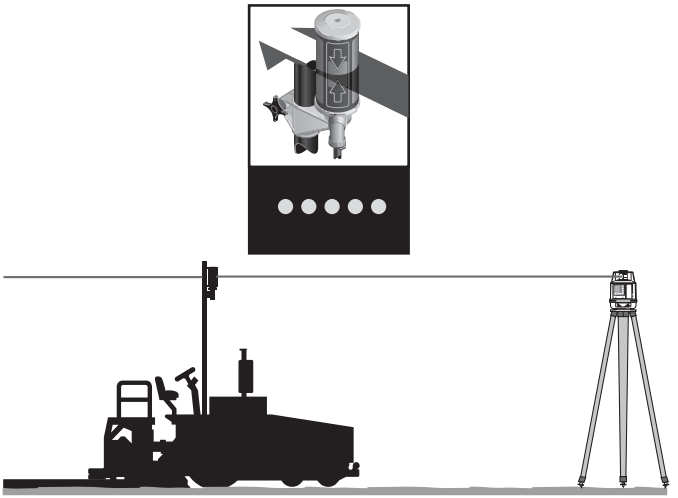


Figure 5-23. Laser Control – On-Grade

As the screed is raised, the beam of light hits the laser receiver below the center and a lower signal is indicated (Figure 5-24 on page 5-31).

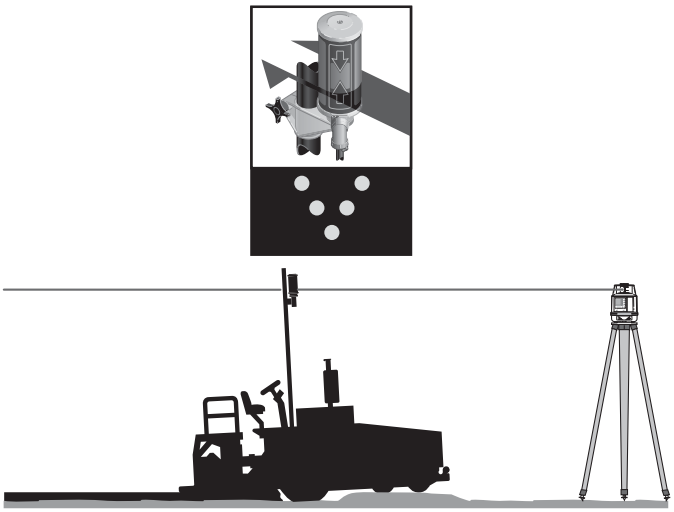


Figure 5-24. Laser Control – Above Grade

As the screed is lowered the beam of light hits the laser receiver above the center, a raise signal is indicated (Figure 5-25).

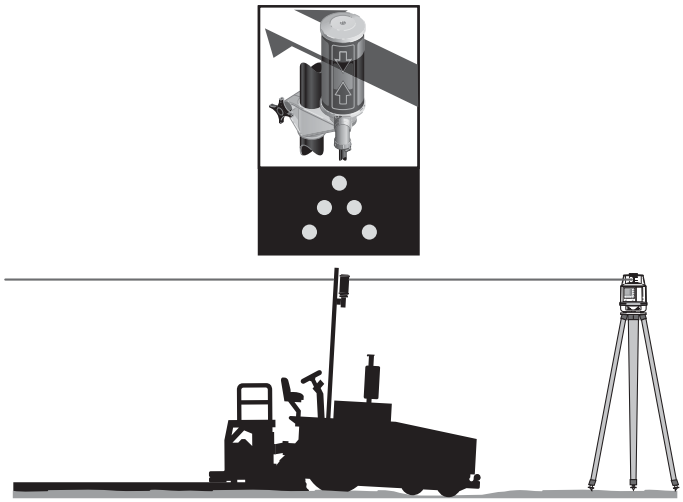


Figure 5-25. Laser Control – Below Grade

Notes:

2D Paving Applications

The type of controls you should use for paving depends on the end result or the finished product you want. Some projects require smoothness and improved rideability. Others are concerned with mat thickness, and some require new asphalt to match curb and gutter or existing grades. Once you have determined the job's requirements, you can set up the correct system and begin paving.

- Some applications require a 2D set up. This chapter discusses using 2D for curbs and joint matching job requirements.
- Some applications can simply use a mmGPS set up. See Chapter 3 for paving with mmGPS.

Using Sonic Control at the Jobsite

If using a Sonic Tracker II at the jobsite, first attach the Sonic Tracker then set up the control box.

When setting up a standard Sonic Tracker II system, consider the following for each tracker:

- The Tracker has a total working range of 14 inches to 55 inches—41 inches of adjustment—allowing the Tracker to be set over a stringline on one pass, then match grade on the next pass without moving the tracker.

  Therefore, the job application determines the position of the Tracker. For example, when using a stringline reference, keep the Tracker about two feet above the string, giving the operator about six inches of lateral movement to keep the Tracker over the string. When tracking a curb, lower the Tracker to keep it over the

lip of the curb, preventing the Tracker from “seeing” the top, or face, of the curb.

- When setting up the Tracker over a grade reference, consider the size of the Sonic Cone, or the “footprint”. For example, at about two feet from the Tracker, the footprint, or cone, is about six inches.
- The Tracker compensates for temperature changes only within the bail range. Placing the Tracker too far from the reference may cause inaccurate temperature compensation.
- Temperature and atmospheric conditions affect the speed of sound. In paving applications, the air temperature can change rapidly and dramatically. A temperature bail attached to the tracker compensates for these variations. If the jobsite has high winds and/or large temperature fluctuations, lower the Tracker closer to the reference.

Step 1: Attach the Sonic Tracker

1. Position the machine next to the reference.
2. Bend the L-bars to align in the same direction and fold inward towards the screed (Figure 6-1). Loosen the clamp handles if needed.

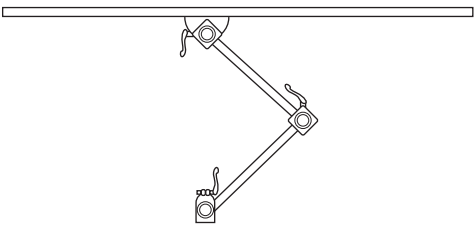


Figure 6-1. Align L-bars

3. Connect the coil cord to the Sonic Tracker (Figure 6-2).

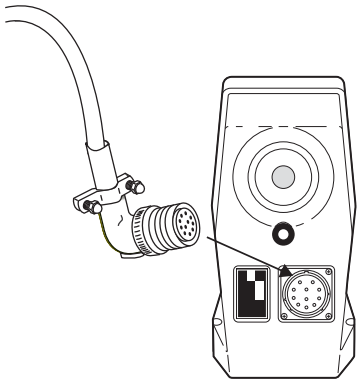


Figure 6-2. Attach Coil Cord to Tracker

4. Bolt the Tracker to the bracket, and visually check to get the L-Bar and Tracker plumb (Figure 6-3 on page 6-4).
5. Loop the coil cable through the “U” hangers or make one wrap of the coil cord around the L-Bar to act as a strain relief for the Tracker’s connector (Figure 6-3 on page 6-4).
6. Snap the temperature bail into place; an LED on the front illuminates (Figure 6-3 on page 6-4). The Tracker is casted with holes on each side for the bail to snap and lock into place.

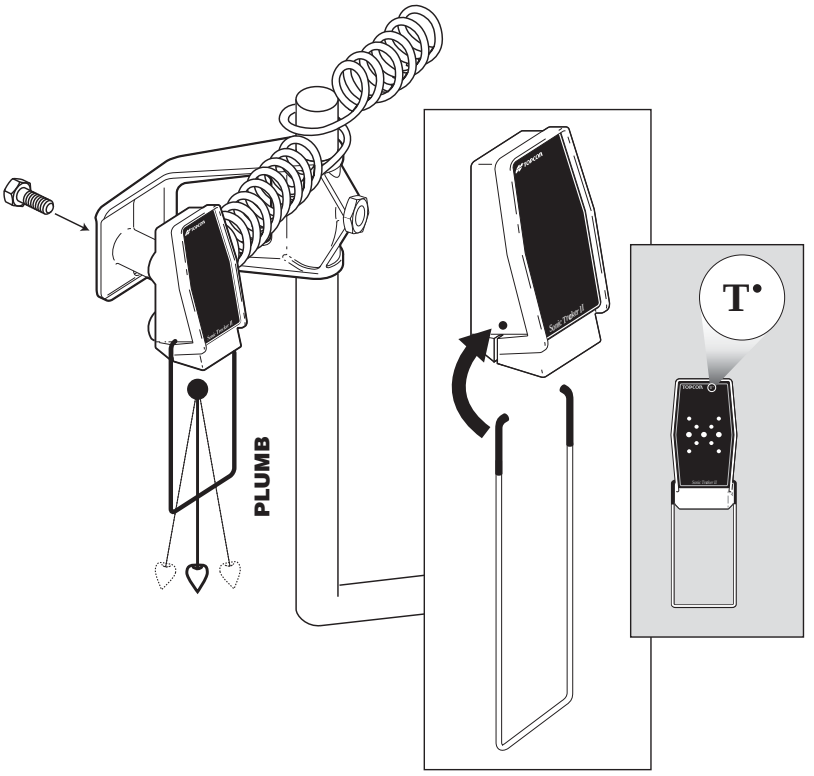


Figure 6-3. Bolt Tracker to Bracket and Attach Temperature Bail

7. Position the L-Bar horizontally so the Tracker rests over the reference for the jobsite (Figure 6-4 on page 6-5).

   For example, when tracking a stringline offset from the edge of the road, set the end of the moldboard at the edge of the road and slide the L-Bar so the Tracker is over the stringline (Figure 6-4 on page 6-5). When tracking a curb, keep the L-Bar in close to keep the Tracker over the lip of the curb.

8. Raise or lower the Tracker bracket to position it at a proper height above the grade reference (Figure 6-4 on page 6-5).

   Although the Tracker can be set as close as 14 inches and as far as 55 inches from the grade reference, consider the job application for the best set up. For example, when tracking multiple references—using elevated string on one pass, then matching

ground on the next pass—consider the Tracker position so it works for both applications without having to move the Tracker.

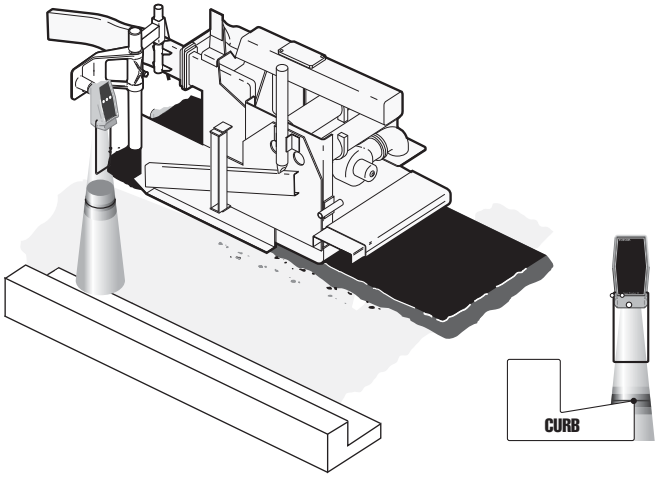


Figure 6-4. Position L-Bar and Tracker Over Grade Reference

Step 2: Set up 9168 Control Box

After attaching the control box to the machine and connecting cable, configure 3DMC for paving with the Sonic Tracker.

In 2D control applications, only the machine configuration file is relevant. Other files, settings, and selections have no affect in this mode. The machine configuration file provides vital information about the type of machine selected All other sensor settings and measurements are ignored. You must have a machine configuration file before beginning to pave.

1. Use the hand knob to attach the control box to the machine (Figure 6-5 on page 6-6).
2. Connect the various electrical cables (Figure 6-5 on page 6-6). Cable connections differ depending on the machine type.

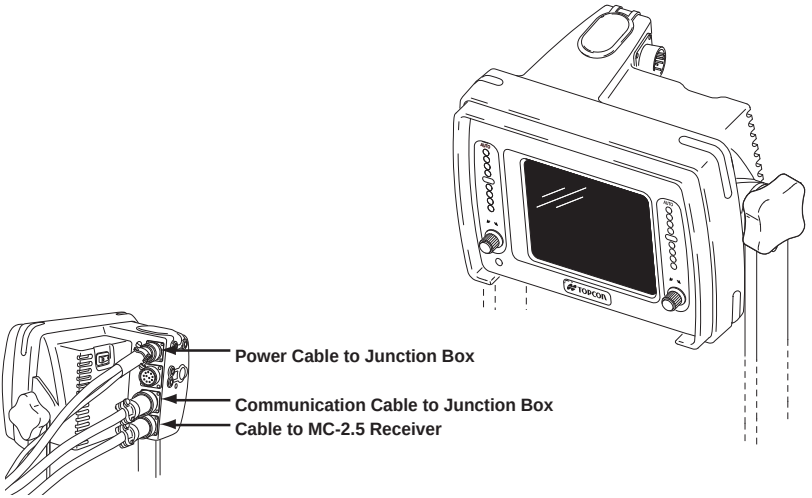


Figure 6-5. Attach 9168 Control Box to Machine and Attach Component Cables

3. Turn on the control box. When 3DMC starts up, press **Topcon Logo ▸ Control ▸ 2D Control** to activate 2D control mode (Figure 6-6).

   3DMC connects to the 2D components and the Elevation Control key displays a sonic tracker.

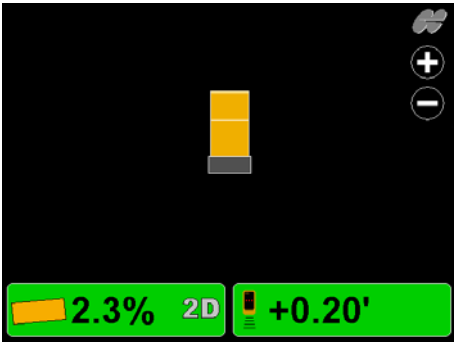


Figure 6-6. 2D Control on the Plan View

4. Press **Topcon Logo ▸ Control ▸ Machine setup**.
5. Select the machine file and press **Ok** (Figure 6-7 on page 6-7). Only the type of machine is important; other sensor settings are ignored.

To create a 2D machine configuration file, see “Creating a 2D Machine Configuration File” on page 6-7.

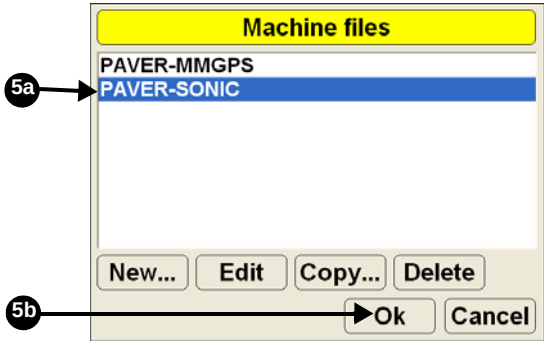


Figure 6-7. Select Machine Configuration File

3DMC Operations for Sonic Tracker Applications

When using the mmGPS 3D Paver system for 2D control applications, only the Control menu, the View menu, the Elevation Control key, and the Slope Control key are relevant to 2D control applications. Other files, settings, and selections have no affect in this mode.

Creating a 2D Machine Configuration File

1. Press **Topcon Logo** ▸ **Control** ▸ **Machine setup**.
2. Press **New** to create a new machine configuration file or select an existing machine configuration file and press **Edit**.
3. Enter or select the following configuration and equipment parameters (Figure 6-8 on page 6-8). Then press **Next**.
   - Configuration name – enter a name for the machine. For easy identification later, include the application type.
   - Machine type – select the type of machine

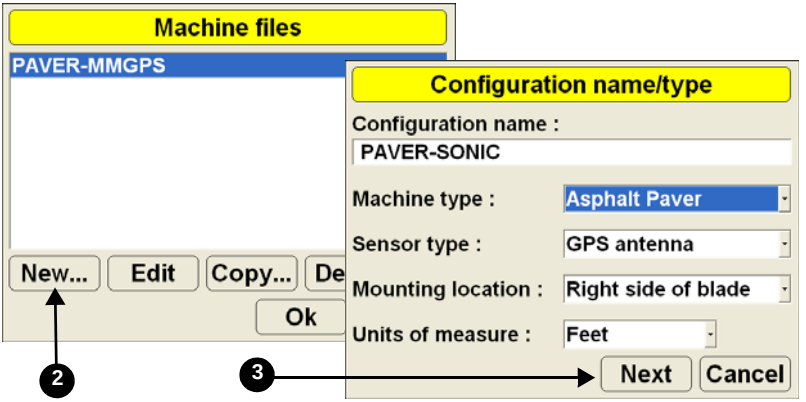


Figure 6-8. Creating the Machine File.

4. Press **Next** until the ***Machine Configuration Complete*** dialog box displays, then press **Finish** to save the file.

Other machine configuration measurements and settings are not required for 2D control applications.

5. Select the machine configuration file on the ***Machine files*** dialog box and press **Ok** to set this as the machine for the job.

You must press Finish to save the file. Failure to do so results in losing all information and require you to repeat the process.

Care and Maintenance of the Sonic Tracker

The following guidelines provide for trouble-free operation:

- Clean and dry all components prior to placing them into the carrying case.
- Ensure that protective connector caps, provided on some components, are in place when not using the cables. Water accumulation on the connectors can cause electrical shorts.
- Do not use high-pressure spray water steam cleaner hoses directly on cables and components. The components can be used in rain or light spraying.
- Check the Sonic Tracker II transducer daily to make sure the filter foam and transducer are clean and free of debris.
  - If the filter foam is clogged with dirt, replace it (see "Sonic Tracker II Transducer Cleaning" on page 6-9).
  - If the transducer appears to be covered with debris, affecting performance, clean or replace the transducer (see "Sonic Tracker II Transducer Replacement" on page 6-10).

Sonic Tracker II Transducer Cleaning

This procedure is not meant to be a regular maintenance procedure. Clean the Transducer only when contamination is suspected or evident.

Cleaning the transducer too much results in a shortened Transducer life and/or water damage to the Sonic Tracker.

1. Hold the Sonic Tracker II™ in an upright position to prevent moisture from inadvertently entering the Sonic Tracker.
2. Mix a mild detergent with water and place the mixture in a spray bottle (use Simple Green® where available).

3. With the Sonic Tracker upright, thoroughly spray the Transducer with the detergent solution.
4. After spraying the Transducer with the detergent, fill the spray bottle with clean water and rinse any residual detergent off of the Transducer.
5. Allow the Sonic Tracker to thoroughly dry.

Sonic Tracker II Transducer Replacement

If the ability of the Sonic Tracker II to "see" a sonic stringline or other reference continues to be impaired, the transducer may be damaged and needs replaced.

1. Remove and discard the Filter Foam—a new filter foam is provided in the Transducer Replacement Kit (Figure 6-9).

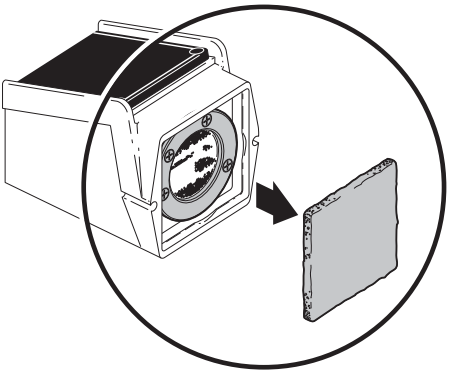


Figure 6-9. Remove Filter Foam

2. Remove the four screws and the black retaining ring. Remove and discard the "O"-Ring (Figure 6-10 on page 6-11).

Always remove and discard used "O"-Rings. Used "O"-Rings are distorted and can loose elasticity due to weather or exposure to diesel fumes.

The Transducer Replacement Kit includes an “O”-Ring and four replacement screws; however, use the original screws and keep the four supplied in the kit for replacements in the event one or more are lost.

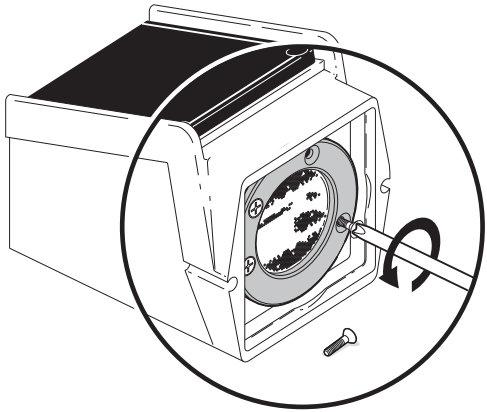


Figure 6-10. Remove Screws, Retaining Ring, and “O”-ring

3. Gently pull out the transducer and use a SMALL pair of dikes to gently cut the Ty-Wrap, then remove the small wire connectors from their tabs (Figure 6-11 on page 6-12).

When cutting the Ty-Wrap, be careful not to cut or damage the wires.

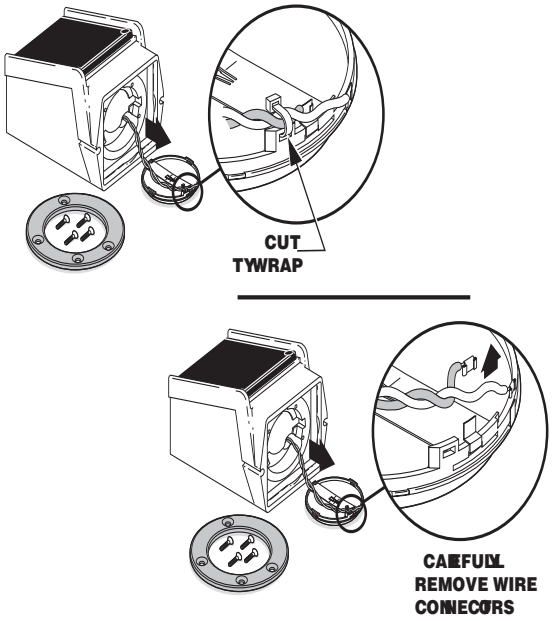


Figure 6-11. Remove Transducer, Cut Ty-Wrap, and Remove Connectors

4. Place the wire connectors of the new transducer firmly on their tabs; the gray wire connector is placed on the elevated tab. Place the Ty-Wrap in the slot next to the elevated (gray wire) tab, tighten and trim. DO NOT pinch the wires (Figure 6-12 on page 6-13).

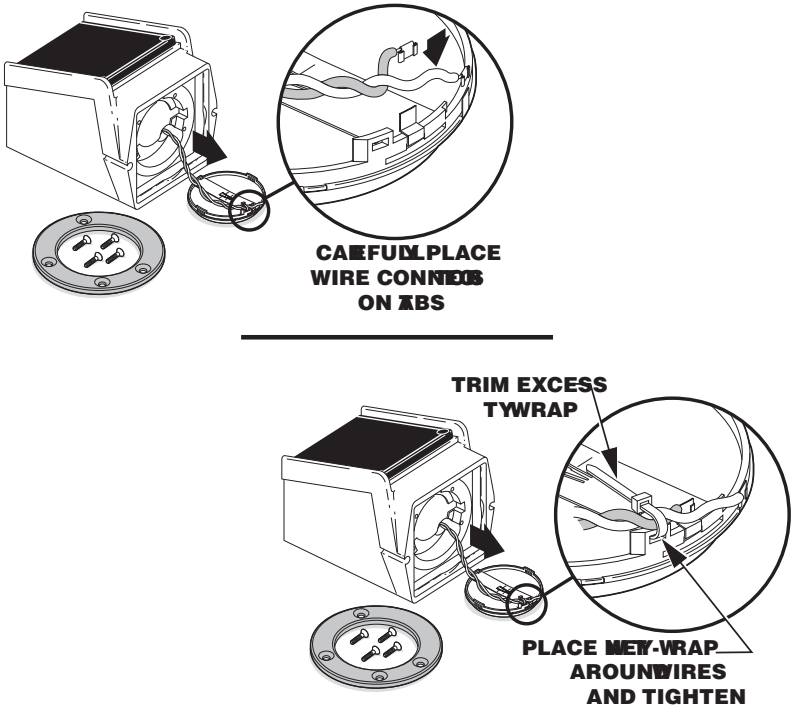


Figure 6-12. Replace Transducer, Connectors, and Ty-Wrap

5. "Feed" the wires back up into the Sonic Tracker II and seat the transducer into place (the two wire tabs have to sit down into the extra deep area of the recess). Place the new "O"-ring around the transducer and seat firmly between the transducer and the Sonic Tracker II transducer recess (Figure 6-13 on page 6-14).

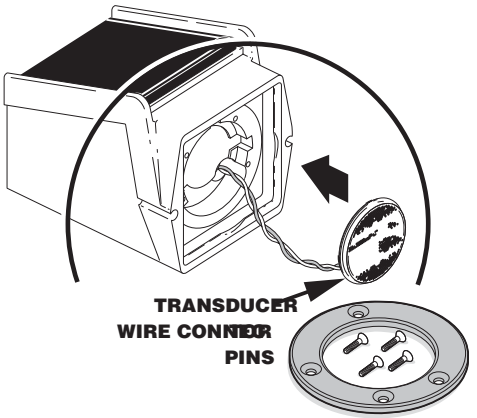


Figure 6-13. Replace Wires, Transducer, and "O"-ring

6. Place the black retaining ring over the transducer assembly with the beveled edges out and the flat surface against the Sonic Tracker II base. Line up the holes for the mounting screws. The mounting screw holes are set to an irregular pattern, ensuring the retaining ring only lines up with the mounting holes one way (Figure 6-14 on page 6-15).
7. Start the mounting screws into the holes and tighten each until firm (Figure 6-14 on page 6-15). DO NOT OVER TIGHTEN. Use a cross (X) pattern when tightening the screws.

NOTICE

DO NOT use Loctite® on the mounting screws. Loctite® attacks and degrades the plastic retaining ring.

NOTICE

Over tightening the screws can distort the transducer metallic material and may crack the retaining ring. The "O"-ring provides tightness while preventing vibration from loosening the mounting screws.

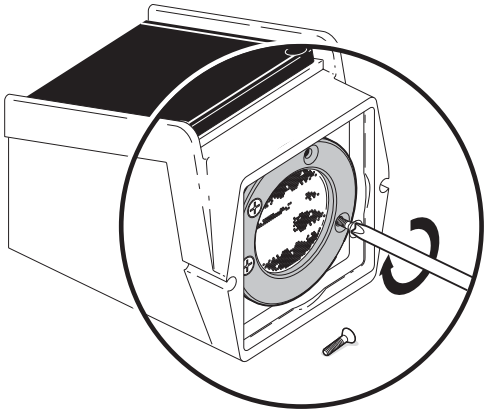


Figure 6-14. Replace and Tighten Mounting Screws

8. Ensure the metallic surface inside the transducer has no visible wrinkles. If distortion is evident, repeat step 5 on page 6-13 to step 8.

Place a new filter foam over the transducer. The Sonic Tracker II is now ready for operation.

Paving City Streets with Sonics

When paving city streets, the general requirement is to lay a mat that is so many inches above the base at the centerline and to match the curb and gutter (Figure 6-15). For this application, sonic control is used on both sides.

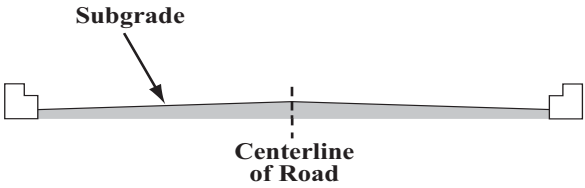


Figure 6-15. Paving to Center Line and to Match Curb

1. Before paving, make sure the machine is properly setup, cross slope is calibrated, and trackers are set in the correct position. See Chapter 3 for details.
2. Position right tracker over lip of gutter and left tracker past the centerline on the base material (Figure 6-16).

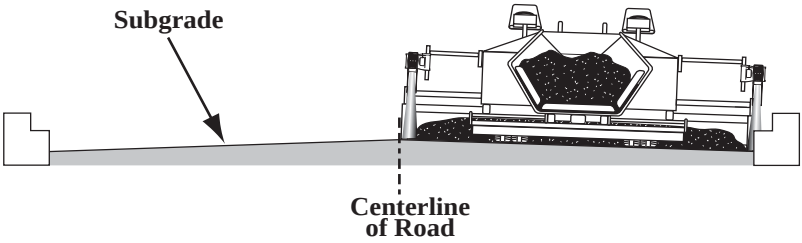


Figure 6-16. Positioning Tracker Over Gutter

3. Press the **Elevation Control key (**Figure 6-17 on page 6-17**)**.
4. Enter an offset value into the *Elevation set point* **Set** entry box.
5. Press **Survey** to quickly lock on-grade.
6. Press **Ok** to return to the Main Screen.

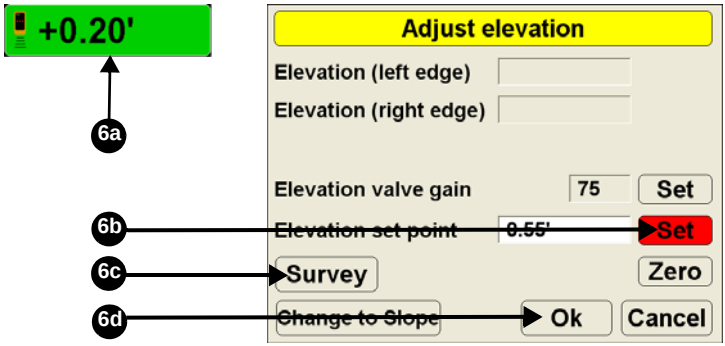


Figure 6-17. Set the Depth of Asphalt to be Laid

7. Switch the A/M Knob into automatic and begin paving. Check the depth of mat at centerline and verify joint matches at lip of gutter. After compaction, make the necessary adjustments.

TIP

If the road width varies, it is easier to keep the tracker over the gutter if the tracker is mounted to the extension on the paver.

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8. To pave the other side of the road, position the left tracker over the lip of the gutter and place the right tracker over the new mat (Figure 6-18).

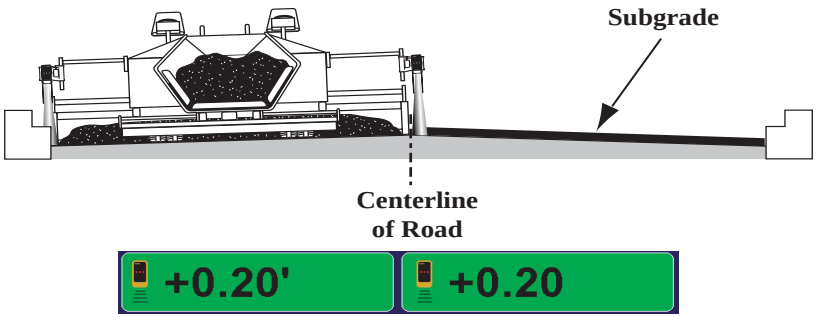

Figure 6-18. Paving Other Side of Road

9. Survey the control box on-grade and set the displays to read the depth of asphalt to be laid (see Figure 6-17 on page 6-17). Put the control box in automatic mode and begin paving. Check to make sure joints match after compaction.

Paving City Streets with Cross Slope

Another option is to pave the street using cross slope and sonic control. The tracker is positioned over the lip of the gutter on one side and cross slope is dialed in for the crown on the other. This method may have to be modified due to the fact that in many cases, the curbs may be poured at different elevations on either side of the street. Even though the curb was poured out of tolerance, it may have passed inspection and the asphalt needs to match the curb and gutter. If the curbs are at different elevations, it is impossible to pave a typical design slope on both sides of the street.

A cross section design of a 36 foot wide street with a 2.0% slope produces a .36 foot rise at centerline (Figure 6-19).

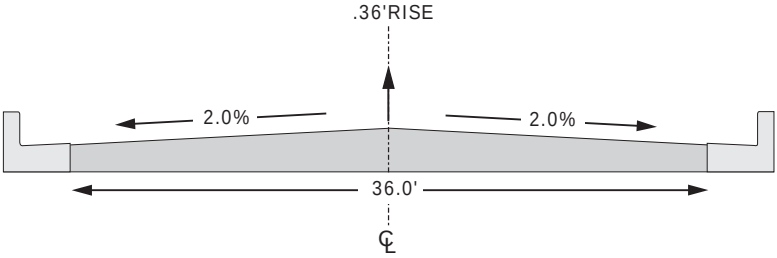

Figure 6-19. Paving with Cross Slope

If the curbs are at different elevations, a .36 foot rise at centerline produces incorrect slopes (Figure 6-20).

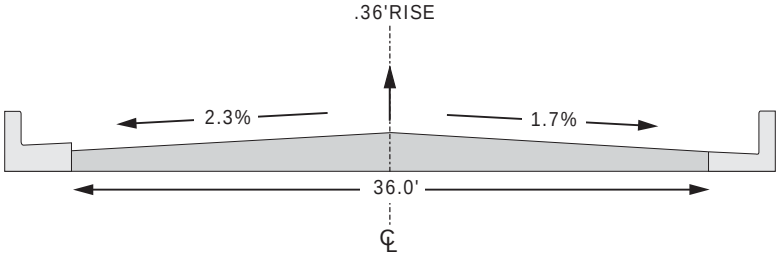

Figure 6-20. Curbs with Different Elevations

When the system is used to pave a true 2.0% slope, the crown of the street is not at the centerline (Figure 6-21).

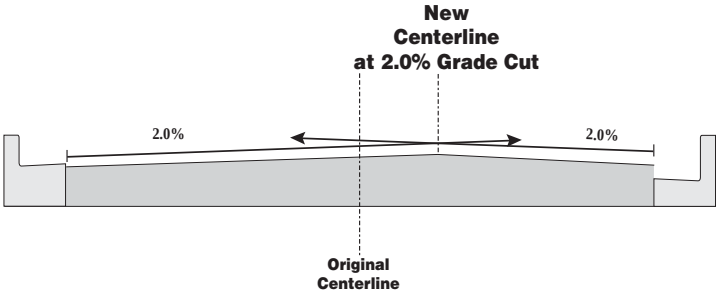

Figure 6-21. Curb with Same Slope

To pave from uneven curbs using slope control, choose the side of the road with the highest curb and position the tracker over the curb. Set the other side for the cross slope you want and begin paving (Figure 6-22).

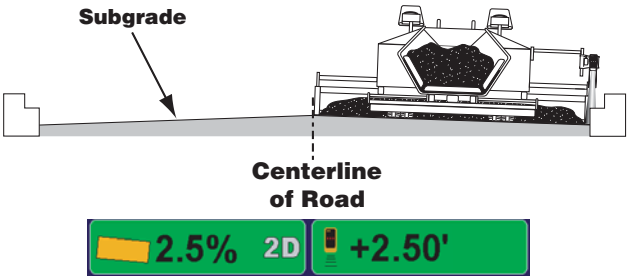

Figure 6-22. Paving Uneven Curbs with Slope Control

To keep the centerline in the middle of the road, the second pass has to be set up with sonic control on each side of the paver. The left tracker matches the lip of the curb and the right side tracker follows the new mat (Figure 6-23 on page 6-20). The cross is not consistent on this side of the roadway, but the joints will match.

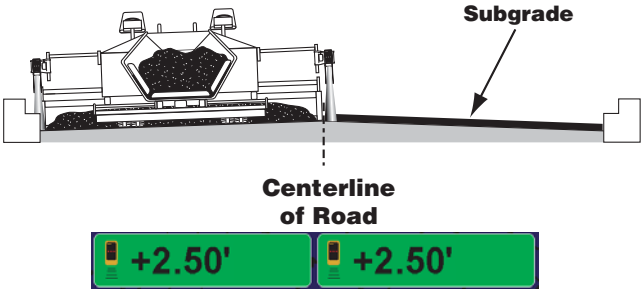

Figure 6-23. Second Pass when Paving Uneven Curbs

The curb elevations can be easily spot checked using a fast leveling RL-HB rotating laser. Set the laser at the lip of one curb, then use the detector and a folding rule to take a reading on the other curb (Figure 6-24). Spot check every 25-50 feet by moving the laser.

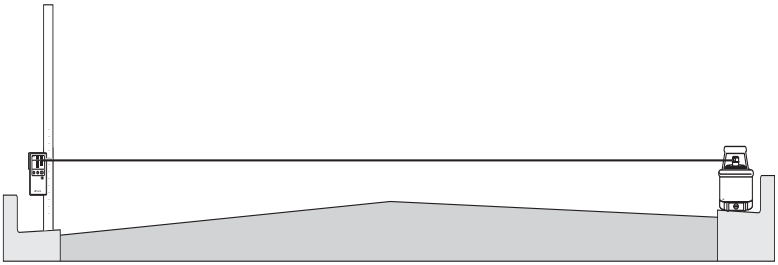

Figure 6-24. Checking Curb Elevations

Paving Streets Through Intersections

As you pave city streets, you will come upon intersections where the curb stops. There are a couple of methods for controlling grade through the intersection.

Method 1 for Paving Intersections

For this method, the base of the intersecting road is used as the reference.

1. With both sides in elevation control, pave to the intersection (Figure 6-25).

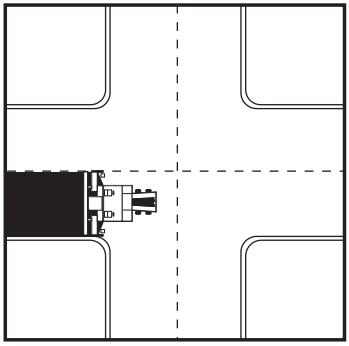

Figure 6-25. Paving Through Intersections

2. Just before the right tracker reaches the end of the curb, switch the A/M Knob into manual mode.
3. Without stopping, continue paving until the right tracker is on the base material of the intersecting road. To quickly lock on-grade to the new reference, press the **Elevation Control key**, then press **Survey** (Figure 6-26) and switch the A/M Knob to put control box back into automatic control.

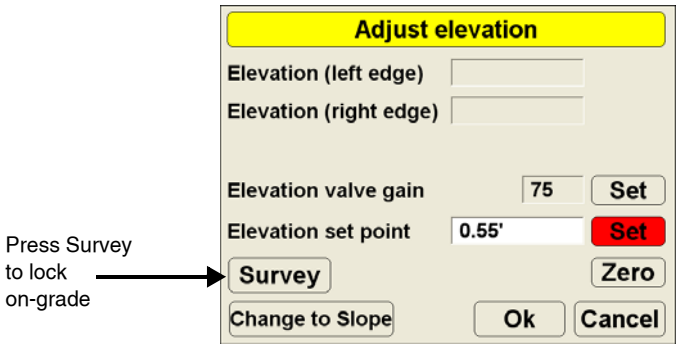

Figure 6-26. Survey to On-grade and Return to Automatic Control

4. Pave through the intersection, and just before the tracker reaches the curb on the other side (Figure 6-27), switch the A/M Knob into manual mode.

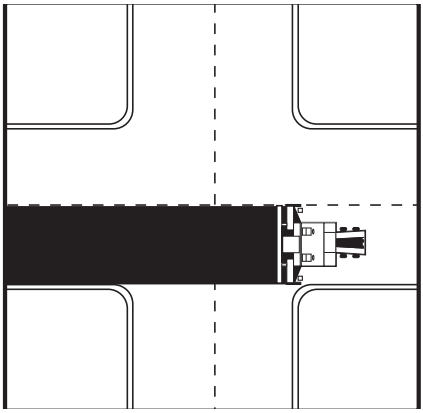

Figure 6-27. Paving Through Intersection

5. Without stopping, continue paving until the tracker is back on the lip of the curb. Survey the tracker on-grade (Figure 6-26 on page 6-21) and put back into automatic control.

You may find after surveying, that for the tracker on the curb the number has changed slightly from the curb on the other side of the intersection. This is due to the different depth of the base below the lip of curbs. While paving, slowly dial the display back to the previous number.

Method 2 for Paving Intersections

Sometimes, the base of the intersecting road is too rough to use as a reference. An alternative is to use a simple piece of stringline.

1. Take a section of 1/8” diameter string and nail or secure it to the curb.
2. Pull the string tight through the intersection and nail or secure it to the other curb (Figure 6-28 on page 6-23).

If the intersecting road has a crown, hike the stringline up in the middle of the road to place the string at the proper height. A hub or a stake with a piece of wire to hold the stringline works fine.

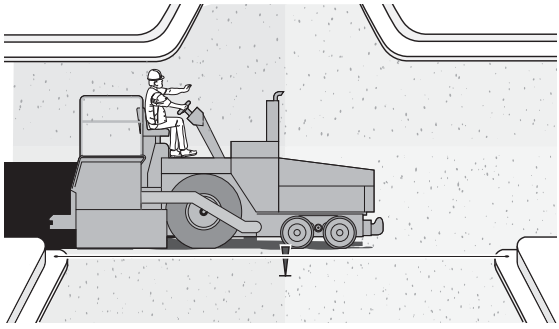

Figure 6-28. Paving Through Intersection Using Hub

This constant reference gives you complete control through the intersection and ensures that you tie in perfectly to both curbs.

Paving Intersections with Cross Slope

When paving with slope, intersections do not require any adjustments if the “mainline” cross slope does not change. If the slope does change, then a combination of slope and tracker should be used (Figure 6-29).

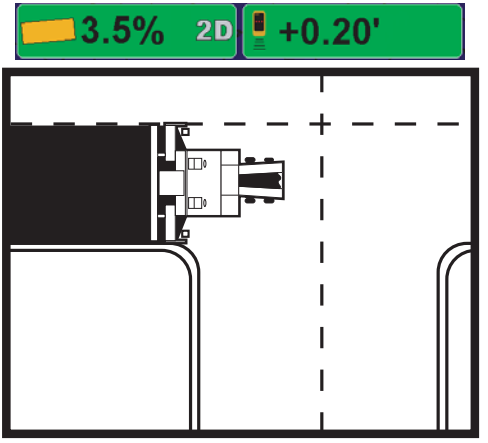

Figure 6-29. Paving Intersections with Cross Slopes

1. Switch the A/M Knob into manual mode just before the slope of the intersection begins to change.
2. Press the **Slope Control Key** to switch from slope to elevation control on the control box.
3. Press **Survey** on the ***Adjust Elevation*** dialog box to survey the tracker on-grade (Figure 6-30 on page 6-25).

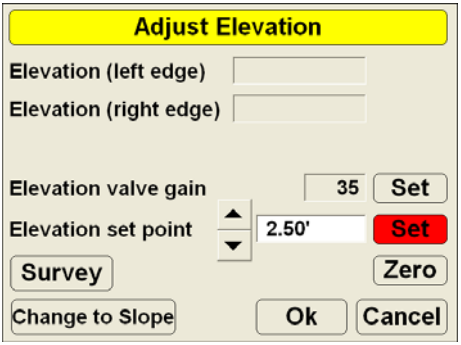

Figure 6-30. Switching to Elevation Control and Surveying On-grade

4. Pave through the intersection with the sonic tracker in automatic (Figure 6-31).

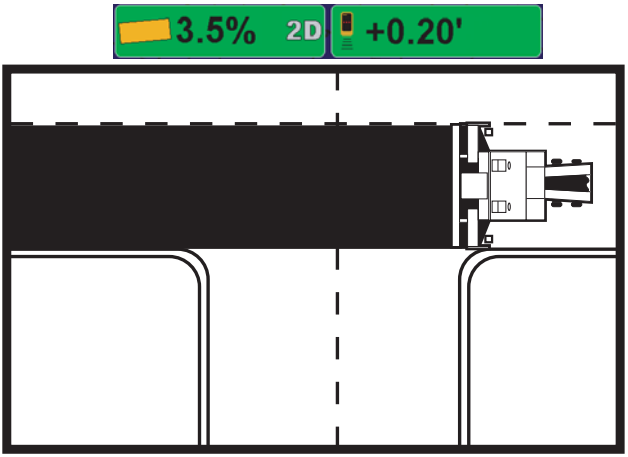

Figure 6-31. Paving Through Intersection

5. Upon reaching the end of the intersection (Figure 6-31), switch the A/M Knob into manual.
6. Press the **Elevation Control key**.
7. Press **Change to Slope**, and Survey the slope to get an on-grade signal (Figure 6-32 on page 6-26).

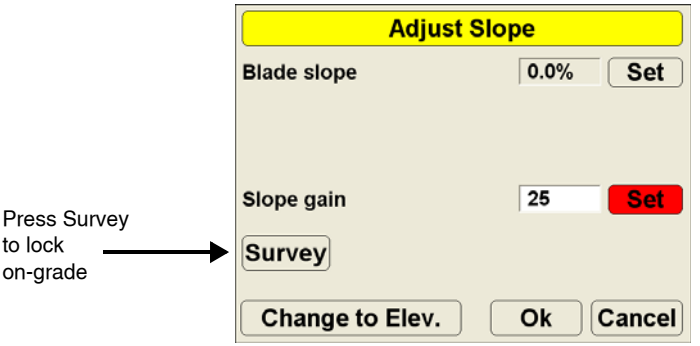

Figure 6-32. Switching to Slope Control and Surveying On-Grade

NOTICE

You may find after surveying the slope that the number displayed is not the same as the cross slope you want. This occurs if the surface being paved is not also at the slope you want.

To get back to the correct slope, continue paving in automatic and slowly dial the display to the slope you want. Failing to survey when changing back to slope control could result in a bump in the mat.

Troubleshooting

In general, as long as you follow the maintenance and safety instructions provided in this manual, you should have few problems with your mmGPS 3D Paver system. This chapter helps you diagnose and solve some common problems you may encounter with the various components.

Before contacting TPS Customer support about any problems, try the following and see the following sections:

- Check that the various components (radio, Receiver Box, control box, Base Station receiver, Base Transmitter, and so forth.) have power and are powered up.
- Check that all cables are securely and properly connected to the various components of the mmGPS 3D Paver system (control box, transmitter, receiver, valves, sensors, and so forth.).
- Disconnect cables and inspect them for damage or contamination. Clean all connections with an electrical contact cleaner.

Do not attempt to repair equipment yourself. Doing so voids your warranty and may damage the hardware.

Base Station

This section lists possible Base Station problems you may encounter (also refer to the Base Station's documentation). If you still have problems after trying the solutions listed here, contact TPS customer support.

Problem	
Legacy-E+ or Hiper Lite receiver does not power on.	
Causes	Solutions
The PWR button was pressed too quickly.	Make sure you hold the PWR button down for at least one second. A quick press will not activate the receiver.
The power cable is incorrectly connected or damaged.	Check that the power cable is correctly connected to the battery—RED to positive and BLACK to negative—and that the battery is charged. Check that the RED dots on the power cable connector and the socket on the receiver are aligned, and the cable is pushed in as far as it can go. If the power cable is damaged, contact your dealer to replace it.
Problem	
Radio modem does not power on.	
Causes	Solutions
The power cable is incorrectly connected or damaged.	Check that the power cable is correctly connected to the battery—RED to positive and BLACK to negative—and that the battery is charged. If the power cable is damaged, contact your dealer to purchase a new cable.

The radio receives power through the Legacy-E+ receiver.	Some radios do not require a separate power supply, but are supplied power through the port on the Legacy-E+. For these radios, check that the Legacy-E+ is also switched on.
Problem	
Pocket-3D does not connect to Legacy-E+ or Hiper Lite+.	
Causes	Solutions
The Legacy-E+ or Hiper Lite may be off.	Check that the Legacy-E+ or Hiper Lite+ is switched on.
The cable may be incorrectly connected.	Check that the cable is connected to the COM port on the computer and Port A on the Legacy-E+. If still no connection, try to reset the computer and repeat.
Problem	
Pocket-3D is waiting for satellites.	
Causes	Solutions
The cable is incorrectly connected or damaged.	Check that the antenna cable is not cross-threaded and is screwed in all the way. If the cable is damaged, contact your dealer to purchase a new cable.
The antenna has poor PDOP.	Check that the antenna has a clear view of the sky.
The receiver is collecting an almanac.	If this is the first time connecting to the Legacy-E+, or if an internal reset has recently been performed, this message may persist for several minutes while the Legacy-E+ obtains a new almanac.

Problem	
Radio modem light is not flashing	
Causes	Solutions
The cable is incorrectly connected or damaged.	Check that the cable from the Legacy-E+ is properly connected to the radio. If the cable is damaged, contact your dealer to purchase a new cable.
The radio does not have a TX LED.	Some radios may not have a TX (Transmit) LED so the radio may in fact be functioning.
The radio has a TX LED, but it is not yet flashing.	All radio types specifically listed for the Base Station kit have a TX light and should flash every second. It may take several seconds after connection for this flashing to commence.

MC-2.5 Receiver Box

This section lists possible MC-2.5 Receiver Box problems you may encounter. If you still have problems after trying the solutions listed here, contact TPS customer support.

Problem	
Power indicator does not flash red.	
Causes	Solutions
The power cable may be incorrectly connected.	Power is supplied through the cable connected on the power port. Check that the cable is properly connected
The control box does not have power.	The MC-2.5 Receiver Box turns on only while the control box is powered on.

The MC-2.5 Receiver Box receives power from another source, which is not on.	If power is supplied through another cable connected to the power port, check that the origin of the power cable, and other connectors, are secure. The power cable may be connected to an ignition switch or a master circuit on the machine, if so, turn on the power source.
Problem	
Satellite Status indicator does not flash green.	
Causes	Solutions
The cable is incorrectly connected or damaged.	Check that the antenna cable is not cross-threaded at the antenna and is connected to the intermediate cable installed on the machine. Check the connection at the GPS antenna port on the MC-2.5 Receiver Box. If the cable is damaged, contact your dealer to purchase a new cable.
The antenna has poor PDOP.	Check that the Machine GPS antenna has a clear view of the sky.
The receiver is collecting an almanac.	If this is the first time connecting to the MC-2.5 Receiver Box, no LED flashing may persist for several minutes while the MC-2.5 Receiver Box obtains a new almanac.
Problem	
Radio Status indicator does not flash yellow.	
Causes	Solutions
The Base Station and/ or Base Station radio has a problem.	Check that the Base Station is running correctly and the TX light on the radio modem flashes on.

Different channels are used between the Base Station and the Rover machine.	Check that the Base Station and Machine use the same radio channel. • For the Base Station, use the button on the radio modem. See “Base Station Initialization” on page 2-9. • For the machine, use the control box function. See “Configure Radios” on page 3-63.
The radio antenna at the Rover or Base may be too low, incorrectly placed, or too far away.	If the yellow LED flashes when near the Base Station, but not when farther away, check that the Rover radio antenna mast is mounted vertically at the highest point on the machine. If the Rover machine gets too far from the Base Station, elevate the radio antenna at the Base Station or move it to a closer Control Point.

GPS Localization

This section lists possible GPS localization problems you may encounter. If you still have problems after trying the solutions listed here, contact TPS customer support.

Problem	
Measurement takes too long.	
Causes	Solutions
The machine may be blocking satellite signals to the range-pole or tripod-mounted antenna.	Watch the status of the measurement screen. If the status indicates “waiting for satellites” move the machine away from the antenna.
The Control Point may be located too close to obstructions.	Move to an alternative Control Point or have the surveyor place a new Control Point away from the obstructions.

The Rover GPS+ has not yet initialized; the system may be tracking many satellites.	The status indicates “waiting for better precision”. The Rover GPS+ may take several minutes to initialize.
The range-pole was unsteady.	Make sure that the pole is held steady while measurement is taking place. Any movement makes for a lengthy initialization and/or measurement.
Problem	
Localization produces large errors.	
Causes	Solutions
A typographical error occurred.	If errors are 10s or 100s of feet or meters, it is likely that a typographical error has occurred. If coordinates are manually entered, check that longitudes are correctly prefixed with a minus sign if working in the western hemisphere (e.g., USA). Re-enter the coordinates.
The range-pole was unsteady.	If the errors are decimeter level in magnitude, it may point to either inaccurately measured local site coordinates or not holding the range-pole vertical when measuring the GPS coordinates.
Inaccurate local site coordinates or erroneous GPS measurement.	If error values of the first few points are reasonable but increase when a new point is measured, the point just measured must have either inaccurate local site coordinates or erroneous GPS measurement.

	To isolate the error, disable horizontal and/or vertical localization for each Control Point in turn and observe the set of errors. When the errors become acceptable due to certain isolation, the point isolated is most likely to detract from the quality of the localization. Also, as a general rule, if error values of the first few points are reasonable but increase when a new point is measured, the point just measured must have either inaccurate local site coordinates or erroneous GPS measurement. Once a problematic Control Point is discovered, try to re-measure the point again to see any improvement. If it is still suspect and affects the acceptable tolerance, the horizontal and/or vertical localization for this point may be disabled.
Problem	
There are no H.Error and V.Error values.	
Causes	Solutions
"Use for horizontal GPS localization" and/or "Use for vertical GPS localization" check boxes may not have been selected.	These check boxes need to be selected for a minimum of three points. Note that the error value is calculated once three Control Points are measured and used for the GPS localization. This troubleshooting is useful when the Pocket-3D is being used to perform GPS localization as well as the control box.

9168 Control Box

This section lists possible 9168 control box problems you may encounter. If you still have problems after trying the solutions listed here, contact TPS customer support.

Problem	
Control box does not power on.	
Causes	Solutions
The cable is the wrong cable, incorrectly connected, or damaged.	Check that the power cable supplies 12 to 24 VDC and is negative conductive. • A socket (positive) = 12 to 24 VDC • E socket = Ground Check that the power cable is connected to the correct port (“Connectors” on page 3-8) and see that the ends are securely fastened. If the cable is damaged, contact your dealer to purchase a new cable.
Problem	
Screen display turns off by itself.	
Causes	Solutions
The fan may be damaged, causing the control box to overheat.	Check that the fan is rotating. If the fan is not rotating, it may be damaged and needs to be replaced with new one. Contact your dealer. Contact your dealer for information on replacing the fan.

Problem	
Screen display goes dim by itself.	
Causes	Solutions
The fan may not be rotating.	Check that the fan is rotating. If the fan is not rotating, it may be damaged and needs to be replaced with new one. Contact your dealer for information on replacing the fan.
The control box has the self-adjusting ability of screen brightness.	Brightness may be reduced when the control box gets over-heated with high temperature around the cab, as well as when the ambient light becomes dim. The backlight also reduces when the ambient light becomes dim.
Problem	
Screen has transferred to operating system.	
Causes	Solutions
"Exit 3DMC" function may have been pressed unexpectedly or incorrectly.	If the screen displays the desktop, the "My Computer" folder should be visible. 1. Double-tap "My Computer" folder. 2. Look for the folder named "Disk C", and double-tap on it. 3. Look for the "Control Box" icon and double-tap on it. The application program opens and returns to the Main Screen.

Problem	
“Control file has no GPS localization” message.	
Causes	Solutions
Not enough Control Points used for localization.	Press the Ok pad to exit the message screen. Check that the Control Points file used has a minimum of three localized points. Perform the localization process again.
No GPS localization has been performed for the project.	Plan to implement the GPS localization. See “GPS Localization” on page 5-18 for detailed instructions.
Problem	
“Loading….” or “Building….” message.	
Causes	Solutions
The program in the control box is in the middle of loading files or making graphics.	If the pointer on the Main Screen moves, when you tap in different places, the control box is computing. When the system is busy, the pointer becomes an hourglass. Wait for a few minutes to let it complete the process. Remember, computing takes longer when a larger file is selected.
If the pointer does not move, the control box may have a computing problem.	Switching off the control box can fix the computing problem.

Problem	
Elevation/Slope Control pad displays: "GPS receiver not connected!"	
Causes	Solutions
Either the GPS+ signal or radio signal is invalid. The graphic may indicate what causes the problem.	For GPS+ signal, check cable connections along the GPS antenna cable from the GPS antenna port on the MC-2.5 Receiver Box to the rover antenna. Check connections at the System Five port on the MC-2.5 Receiver Box and Connector D (bottom) on the 9168 control box.

Problem	
Elevation Control key displays: "Waiting for radio link"	
Causes	Solutions
Radio transmission, radio antenna, lights status on the Legacy-E+ receiver, and/or power may have a problem.	Check that the Base Station is working correctly. See "Equipment Setup and Initialization: Base Station" on page 5-2 to troubleshoot Base Station problems. Also check that the Rover radio antenna on the machine and its cable connections are properly connected. Make sure that the radio channel is identical between the Base Station and the machine rover, and that the radio is correctly configured on the control box. See "Equipment Setup and Initialization: Base Station" on page 5-2 and "Equipment Setup: Machine Components" on page page 5-6 for information.

Problem	
Elevation Control key displays: "Waiting for Initialization"	
Causes	Solutions
The MC-2.5 Receiver Box has not been successful tracking enough valid satellites.	Check that the rover GPS antenna has a clear view of the sky. Check for obstructions, such as trees, buildings, and vehicles, that can block or reflect satellite signals.
The system is still in the process of determining a solid position.	If this is the very first time for operation, this message may persist for several minutes while the Legacy-E+ or Hiper Lite obtains a new almanac.

Problem	
Elevation Control key displays: "Out of design area"	
Causes	Solutions
The machine is out of the Design Surface area.	Make sure that the correct Control Point File and Design Surface file is selected. Move into the Design Surface area so the operator can start grading.

Problem	
Elevation Control key displays : "No GPS localization"	
Causes	Solutions
The Control Points file currently selected has not been localized properly.	Make sure that the correct Control Point file currently is selected.

You are in a process of building a Control Point file or just starting the process.	Disregard the message until the localization is complete. See “GPS Localization” on page 5-18 to perform localization.
Problem	
Slope Control key displays: “Slope sensor not connected!”	
Causes	Solutions
Cross slope system is not connected properly.	Check cable connections from the Connector C on the 9168 control box (third from the top), to the Junction Box and from the Junction Box to the slope sensor.
Problem	
Elevation Control key displays: “ELEV sensor not connected!”	
Causes	Solutions
2D Control sensor is not properly connected.	Use the correct coil cord. Ensure the cable connections between the Junction Box (dozer) and the elevation sensor are correct and secure. Use the correct location at the Junction Box to connect the coil cord. For example, when selecting the right side for elevation control, use the right side connector on the Junction Box to connect the coil cord.
Wrong control mode selected.	Deactivate 2D Control Mode: tap **Topcon Logo ▸ Control ▸ 2D Control**.

Safety Information

It is your responsibility to be completely familiar with the cautions described in this manual. These messages advise against the use of specific methods or procedures which can result in personal injury, damage to the equipment, or unsafe operating conditions. Remember, most accidents are caused by failure to observe basic safety precautions.

General Precautions

1. Read and become familiar with the machine manufacturer's operating instructions, including safety information, before installing or using your Topcon equipment.
2. Use extreme caution on the jobsite. Working around heavy construction equipment can be dangerous.
3. DO NOT attach system brackets or hose connections while the machine is running.
4. DO NOT allow any mmGPS 3D Paver system component to limit the visibility of the operator.
5. Use Ty-wraps, supplied with the mmGPS 3D Paver system, to keep hoses and wires secured and away from possible wear or pinch points.
6. Use eye protection whenever welding, cutting or grinding is being done on the machine.

7. Protect yourself at all times, and wear protective clothing, when working on or near hydraulic lines. Hydraulic lines can be under extreme pressure, even when the machine is turned off.

Relieve all pressure in the hydraulic lines before disconnecting or removing any lines, fittings or related components. If injury does occur, seek medical assistance immediately.

8. Avoid direct exposure to your eyes when using laser control.

DO NOT stare into the laser beam or view the beam directly with optical equipment.

9. Use appropriate welding precautions and practices when welding. After welding, all paint all affected areas with a rust inhibitor.

DO NOT weld near hydraulic lines or on any equipment when in operation.

Disconnect all Topcon system electrical cables prior to welding on the machine.

All mounting bracket welds must be secure and strong to prevent the sensor equipment from vibrating excessively or from becoming detached at the weld during operation.

10. To prevent vandalism or theft, do not leave removable Topcon components on the machine at night. Remove the components each evening and store appropriately in the carrying case.
11. Keep the carrying case dry at all times.

DO NOT allow moisture to get inside the case. Moisture trapped in the case can adversely affect components.

If moisture does enter the carrying case, leave it open and allow it to thoroughly dry before storing any components.

Radio Usage Information

All users must obtain an FCC (Federal Communications Commission) license before operating the GPS+ system, GPS RTK (Real-Time Kinematic), or simultaneous calculation of Global Positioning System and Global Navigation Satellite System.

- **The Federal Communications Commission is at:**

  http://www.fcc.gov/

- **The rules are at:**

  http://www.access.gpo.gov/nara/cfr/waisidx_00/47cfr90_00.html

There have been many problems in the past with RTK base radio modems interfering with voice users. The issue finally culminated with the FCC refusing to grant licenses until something was done to ensure that surveyors did not interfere with voice users. The solution was to stop using frequencies in the 469MHz range, to add an identifier to the broadcast message, and other measures designed to minimize interference with voice users. The user and his employer are subject to fines of up to $82,500, confiscation of surveying equipment and legal action, if the rules are ignored.

Topcon cannot obtain the license for the user. There are companies to assist with licensing. Two are listed here:

- **Professional Licensing Consultants Inc.**

  P.O. Box 1714
  Rockville, MD 20849-1714

- **Atlas License Company and Data Services**

  1725-A North Shadeland Avenue
  Indianapolis, IN 46219

  http://www.alcds.com/

Notes:

Specifications

The sections in this appendix give the features and specifications for the physical components of the mmGPS 3D Paver system.

Control Box

The 9168 control box is backward compatible with System Four+ and System Five sensors and remote switches. Table B-1 lists specification details for the 9168 control box.

Table B-1. 9168 Control Box Specifications

Housing	Cast aluminum
Weight	11.75 lb. (5.3 kg)
Display	Color LEDs 6-1/4" diagonal, sunlight viewable 640 x 480 enhanced color, 1300 nit Touch screen Three-color, linear grade indicators with automatic adjustable brightness
Supply Voltage	10 to 30 VDC
Operating Current	Typical: 3.0 A Maximum: 15 A
Operating Temperature	-20 to +60°C (-4 to 140° F)
Moisture	MIL standard 810D
Valve Drive	Progammable dual hydraulic control.
External data storage	One slot for compact flash card to download/upload job files

Table B-1. 9168 Control Box Specifications (Continued)

USB Port	One port for keyboard or mouse hookup
Connectors	Four connectors for power, valves, RS485, RS232
Speaker	For the tones, beeps, and chimes of audible alerts
Computer Board	300 MHz processor 28 MB SDRAM
Operating System	Microsoft Windows® CE.NET™

Figure B-1 shows the dimensions of the 9168 control box.

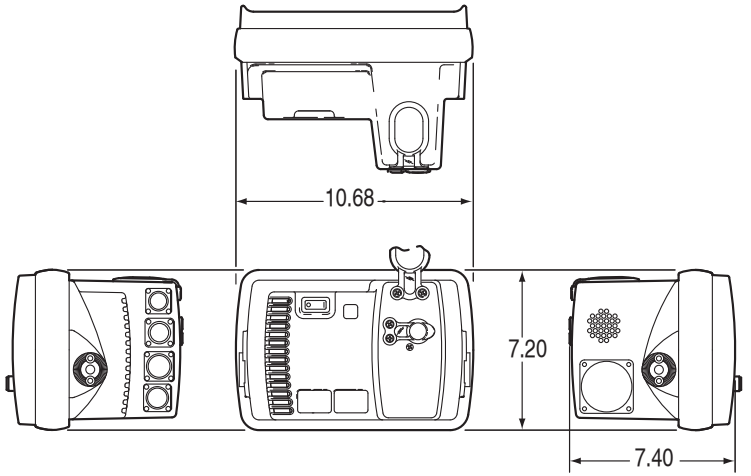

Figure B-1. Control Box Dimensions

Blade Slope Sensor

The Blade Slope Sensor provides superior accuracy and repeatability, is free adjusting, and has a rugged, sealed design. Table B-2 lists component specification for the Blade Slope Sensor.

Table B-2. Blade Slope Sensor Specifications

Resolutions	+/- 0.025% slope
Range	9151: +/- 0-20% slope 9153: +/- 0-100% slope
Supply Voltage	10 to 30 VDC
Supply Current	100 mA (typical operating current)
Emissions	Applicable regulation: EN55022:1994 30-230MHz : 40dB (mV/m) Max at 10m 230-1000MHz: 47dB (mV/m) Max at 10m
Immunity	Applicable regulation: EN50082-1:1992 ESD: +/- 8KV RF: 27 to 500MHz 3V/m Fast transient: +/- 0.5KV capacitively coupled
Network	Topcon proprietary RS-485 network port
Housing	Cast aluminum Note: See envelope dimensions section
Connectors	MIL-C-5015 cylindrical connectors Gold Plated Contacts Conductive anticorrosive coating 9151 (10 pin screw) 9153 (11 pin bayonet w/dust caps
Operating Temperature	0°C to 60°C

Figure B-2 shows the dimensions of the Blade Slope Sensor.

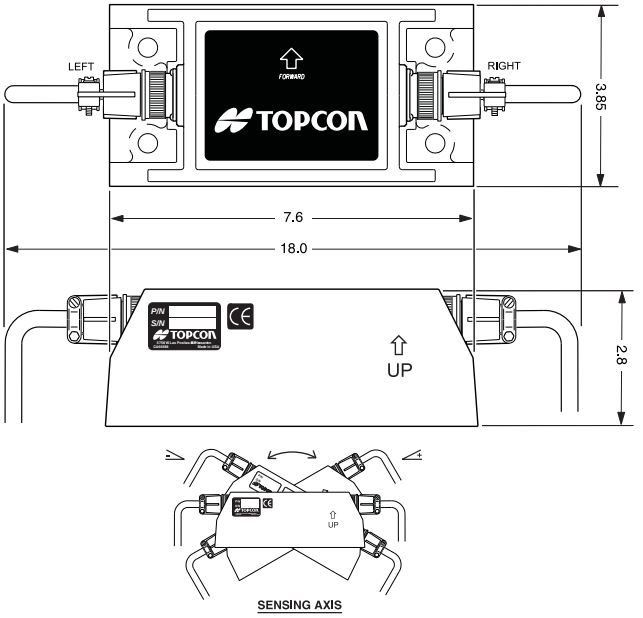

Figure B-2. Blade Slope Sensor Dimensions

Simple Auto/Manual Knob

The Simple Auto/Manual Knob mounts on the control lever for easy access. Table B-3 lists specification details for the Simple Auto/Manual Knob.

Table B-3. Simple Auto/Manual Knob Specifications

	Details
Profile	Epoxy
Switches	One for switching between Auto and Manual control
Mounting Threads	.375-16 x.60 inch deep course threads

Figure B-3 shows the dimensions of the Simple A/M Knob:

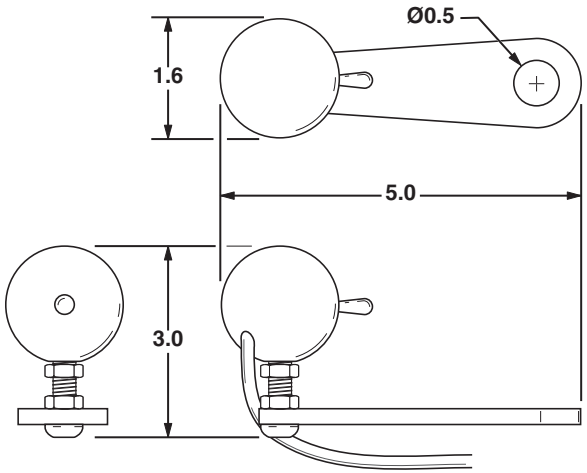

Figure B-3. Simple Auto/Manual Knob Dimensions

MC-2.5 Receiver Box

The MC-2.5 Receiver provides the industry's most advanced GLONASS and GPS dual-frequency satellite tracking system in a heavy-duty construction design with a shock absorbing mounting bracket. Four, high-power, bottom mounted magnets keep receiver in place on machine. The receiver also features compliance with CMR and RTCM industry standards and has optional advanced multipath mitigation and optional in-band interference rejection. Table B-4 lists specification details for the MC-2.5 Receiver Box.

Table B-4. MC-2.5 Receiver Box Specifications

Housing	Cast aluminum
Weight	12.10 lb. (5.5 kg)
LEDs	Three LEDs: Power (red); Satellite status (green for GPS; green and red GPS and GLONASS); Radio status (yellow)
Supply Voltage	10 to 30 VDC

Table B-4. MC-2.5 Receiver Box Specifications

Radio	Built in UHF or Spread Spectrum
Radio Frequency Band	UHF 450 to 470 MHz Spread Spectrum 915
Channels	14 for Pacific Crest PDL 6 for TeleDesign TS4000
Channel Switching	Manual for Pacific Crest PDL Clear channel scan for TeleDesign TS4000
Baud Rate	Up to 38400 bps
RTK Update Rate	10 Hz
GPS+ Tracking Channels	20 channels GPS L1+L2+GLONASS

Figure B-4 shows the dimensions of the MC-2.5 Receiver Box:

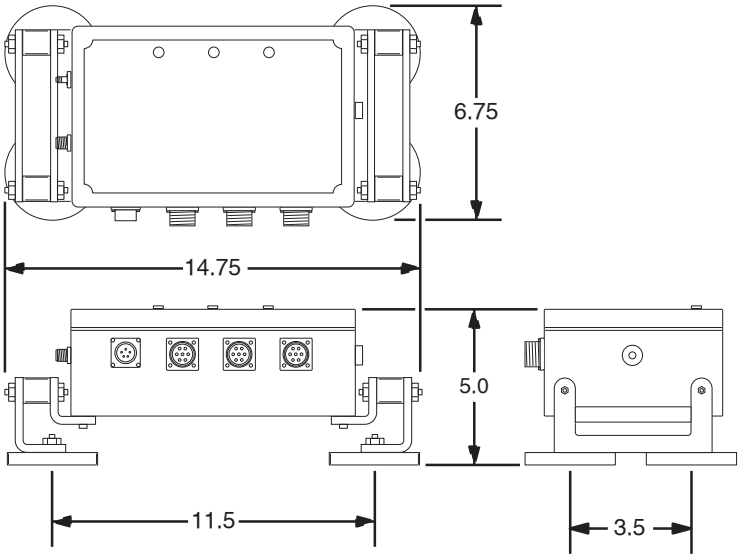

Figure B-4. MC-2.5 Receiver Box Dimensions

PZS-MC Sensor

The PZS-MC sensor combines the MC-A1 GPS antenna with laser sensor technology. The sensor attaches to a GPS vibration pole on the machine blade, and cables connect the receiver to the control box. Table B-5 lists specification details for the PZS-MC Sensor.

Table B-5. PZS-MC Sensor Specifications

Beam Detection	±10° by ±10° window
Channels	4
Weight	6.6 lbs (3kg)
Power Supply	DC 8V~DC 32V
Waterproof	IPX6
Operating Temperature	-20°C to +50°C (-4°F to 122°F)

Figure B-5 shows the dimensions of the PZS-MC Sensor:

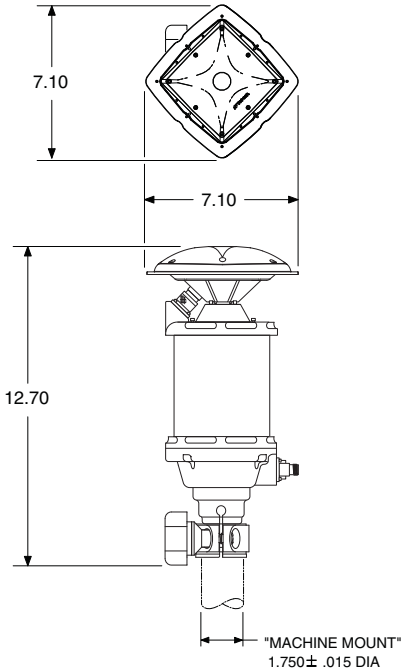

Figure B-5. PZS-MC Sensor Dimensions

GPS Vibration Pole

The GPS Vibration Pole features a steel pole with a larger diameter to improve stiffness. Increased temperature range is provided by the use of high or low temperature bushings. Table B-6 lists specification details for the GPS Vibration Pole.

Table B-6. GPS Vibration Pole Specifications

Housing	Base: Cast aluminum; Pole: OD 1.75 in extruded aluminum
Range	6 ft 7-1/2 in (201.9cm)
Weight	29.0 lbs (13.0 kg)

Figure B-6 shows the dimensions of the GPS Vibration Pole:

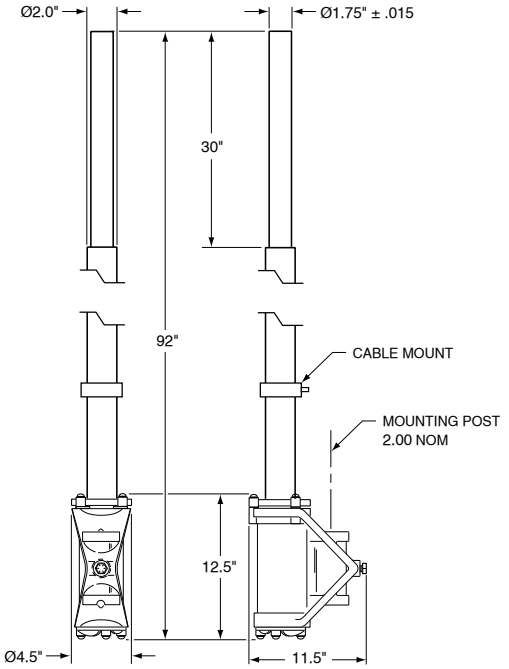

Figure B-6. GPS Vibration Pole Dimensions

Trackerjack Vibration Pole

The Trackerjack Vibration Pole has a lightweight, shock isolation, and vibration dampening design and is reinforced for rough applications. Table B-7 lists specification details for the Trackerjack Vibration Pole.

Table B-7. Trackerjack Vibration Pole Specifications

Housing	Base: Cast aluminum; Pole: OD 1.75 in extruded aluminum
Range	5 ft 1-1/2 in (156.2cm)
Weight	22.3lbs (10.15kg)

Figure B-7 shows the dimensions of the Trackerjack Vibration Pole:

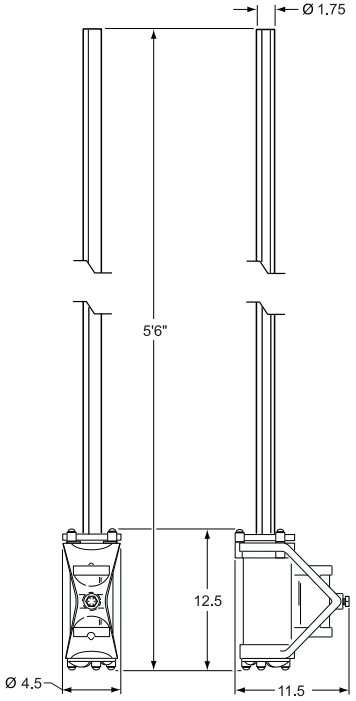

Figure B-7. Trackerjack Vibration Pole Dimensions

Laser Tracker

The Laser Tracker features bright indication lights, built in valve drivers for indicate and proportional automatic control, and a motor drive for attachment to the Trackerjack. Table B-8 lists specification details for the Laser Tracker.

Table B-8. Laser Tracker Specifications

Housing	Base: cast aluminum Body: polycarbonate
Detector Height	5 1/2 in
Mounting Thread	5/8-11 in
Supply Voltage	10 to 30 VDC
Operating Current	Typical: 200 mA
Operating Temperature	0 to +60 deg C (32 to 140 deg F)
On-grade Zone	+/- 0.013ft (variable with beam spot)
Beam Acceptance	360°

Figure B-8 shows the dimensions of the Laser Tracker:

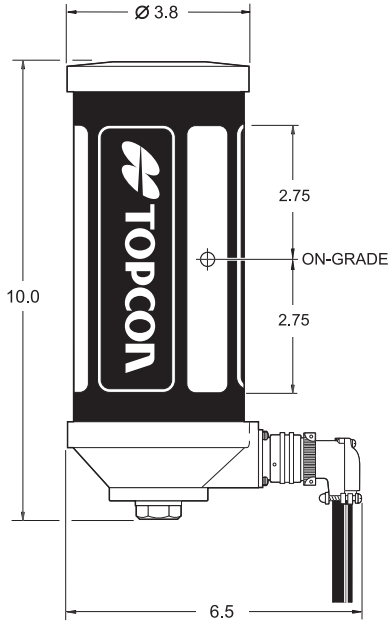

Figure B-8. Laser Tracker Dimensions

Trackerjack

The Trackerjack has driving capabilities on a Trackerjack Vibration Pole, is lightweight, and has manual override buttons for pole installation. Table B-9 lists specification details for the Trackerjack.

Table B-9. Trackerjack Specifications

Enclosure	Cast aluminum
Weight	4.7 lbs (2.13 kg)
Supply Voltage	12 VDC for 9221 24 VDC for 9220
Operating Current	Typical: 0.5A Maximum: 10.5A
Operating Temperature	0 to +60 deg C (32 to 140 deg F)

Figure B-9 shows the dimensions of the Trackerjack:

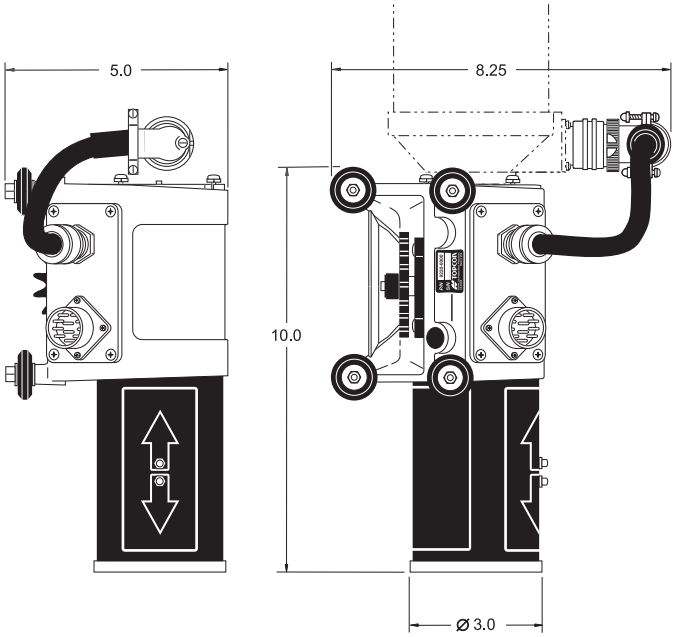

Figure B-9. Trackerjack Dimensions

Sonic Tracker II

The Sonic Tracker II™ has ruggedly sealed electronics, a field replaceable sonic transducer, and temperature compensation for atmospheric disturbances that contribute to industry standard accuracies. With bright grade indication lights and a patented working window, it's easy to use and see for controlling grade. Table B-10 lists specification details for the Sonic Tracker II™.

Table B-10. Sonic Tracker II Specifications

Housing	Cast aluminum; Epoxy sealed electronics
Connector	1 for power and communication
Display	Raise/lower/on-grade LED's
Supply Voltage	10 to 30 VDC
Operating Current	Typical: 200 mA
Operating Temperature	0 to +60 deg C (32 to 140 deg F)
Range	Adjustable from 14 to 55 inches (35.5 to 140 cm)
Working Window	On-grade adjustable Course: 0.15 ft Fine: 0.05 ft
Resolution	0.0025 ft.
Transducer Frequency	50 kHz with 40 Hz maximum repetitive rate

Figure B-10 shows the dimensions of the Sonic Tracker II:

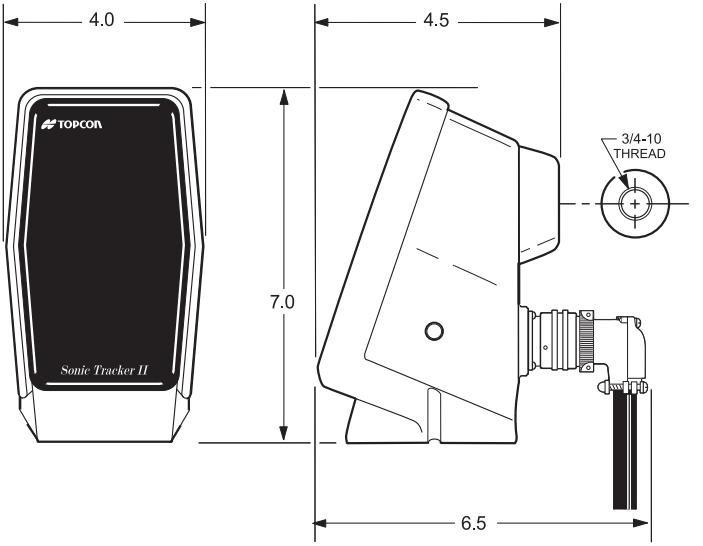

Figure B-10. Sonic Tracker II Dimensions

Regulatory Information

The following sections provide information on this product's compliance with government regulations for use.

UHF Radio Usage

Using a UHF radio requires a license. Operating a UHF radio without a license may result in fines or other penalties. Be sure you comply with all local laws before operating a UHF radio. Contact your local authorities (such as, the FCC in the United States) for details.

Surveying in RTK mode has made UHF the most popular choice for communications between Base and Rover receivers. Know the strengths and weaknesses of this technology to get the best use out of your receiver. The quality and strength of the UHF signals translates into range for UHF communications.

1. The system's range greatly depends on the local conditions. Topography, local communications and even meteorological conditions play a major role in the possible range of RTK communications. If needed, use a scanner to find clear channels.
2. The system's range increases by adjusting the Base station's antenna using the following methods.
   - Ensure the Base radio has a fully charged battery.
   - Use directional antennas and/or repeaters to increase your system's range. Directional antennas concentrate the signal power within a more narrow direction, significantly increasing the range of your system.

- Check the TPS accessory line for items to raise the Base radio.

FCC Compliance

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause an unwanted operation.

This equipment has been tested and found to comply with the limits for a digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in residential installations. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause interference to radio or television equipment reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Move the equipment away from the receiver.
- Plug the equipment into an outlet on a circuit different from that to which the receiver is powered.
- Consult the dealer or an experienced radio/television technician for additional suggestions.

Any changes or modifications to the equipment not expressly approved by the party responsible for compliance could void your authority to operate such equipment.

Community of Europe Compliance

The product described in this manual is in compliance with the R&TTE and EMC directives from the European Community.

Canadian Emission Labeling Requirements

1. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause an unwanted operation of the device.
2. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.
3. This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe B respecte conform a la norme NMB-003 du Canada.

WEEE Directive

Following information is for EU-member states only:

The use of the symbol indicates that this product may not be treated as household waste. By ensuring this product is disposed of correctly, you help to prevent potential negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling of this product. For more detailed information about the take-back and recycling of this product, please contact your supplier where you purchased the product or consult.

Warranty Terms

TPS laser and electronic positioning equipment are guaranteed against defective material and workmanship under normal use and application consistent with this Manual. The equipment is guaranteed for the period indicated, on the warranty card accompanying the product, starting from the date that the product is sold to the original purchaser by TPS' Authorized Dealers.[1]

During the warranty period, TPS will, at its option, repair or replace this product at no additional charge. Repair parts and replacement products are furnished on an exchange basis and are either reconditioned or new. This limited warranty does not include service to repair damage to the product resulting from an accident, disaster, misuses, abuse or modification of the product.

Warranty service may be obtained from an authorized TPS warranty service dealer. If this product is delivered by mail, purchaser agrees to insure the product or assume the risk of loss or damage in transit, to prepay shipping charges to the warranty service location and to use the original shipping container or equivalent. A letter should accompany the package furnishing a description of the problem and/or defect.

The purchaser's sole remedy shall be replacement as provided above. In no event shall TPS be liable for any damages or other claim including any claim for lost profits, lost savings or other incidental or consequential damages arising out of the use of, or inability to use, the product.

1. The warranty against defects in Topcon battery, charger, or cable is 90 days.

Service Information Service assistance can be provided by contacting your local TOPCON dealer or by calling the Corporate Service Center.

Phone: (800) 443-4567
8 a.m. to 5 p.m. Pacific Time
Monday through Friday

FAX: (925) 460-1329

Travel charges are applied for any on-site service whether warranty or non-warranty in nature.

Glossary

A

Aggregate

Various hard, inert materials such as sand, gravel, pebbles, etc. used as the bulk material in asphaltic mixes.

Angle of Attack

The angle that exists between the bottom of the screed and the grade over which the screed is traveling.

Auger

The broad, spiral flange on a screed which rotates and spreads paving material evenly in front of the screed.

Auger Shadows

The dark and light areas along the length of a mat surface caused by the compaction of materials having different densities and textures.

Automatic Grade and Slope Controls

Sensing equipment used on paving machines to set and maintain proper elevations and percent slope. The mmGPS 3D Paver system provides paver operators with automatic grade and slope control.

B

Bail

A wire frame added to the Tracker that acts as a fixed target to compensate for rapid air temperature changes.

C

Calibration

Setting the elevation reading or Slope Sensor reading to match the actual position of the screed.

Compaction

To press tightly, thereby increasing the density of paving material.

Cone

Pattern of distribution of the Sonic Tracker II™ sound waves. The sound waves leave the Tracker in a circular pattern that gets wider as it gets further from the Tracker.

Conveyor

The assembly used to move paving material from the hopper to the auger.

Cross Slope

The angle of slope required to produce a selected surface slope. Cross slope is measured in percent.

Crown

The transverse contour of a finished mat.

The contour of the screed plate.

The transition line between two different slopes (that is, between lanes or between lanes and shoulders).

D

Density

Compactness of paving material.

E

Elevation

The vertical height or depth of the surface being laid. Elevation is measured in centimeters, inches, or feet.

G

Grade

The base surface (road bed) over which paving is being laid.

The elevation of a fresh mat in relation to the base.

The incline of a paving surface in the direction of travel, expressed by stating the rise or fall as a percentage of horizontal distance.

(that is, 6% grade = 6' of elevation change in 100' of horizontal longitudinal run).

Grade Control

A means of controlling the elevation of a mat as it is being laid.

H

Head of Material

The volume of paving material directly in front of and across the entire length of the screed.

Hopper

The area at the front of the paving machine which receives the paving material.

Hydraulic

Liquid in motion under pressure, the flow of which causes work to be accomplished.

L

LCD

Liquid Crystal Display. LCD is used in the display window on the 9168 Control Box and Sonic Tracker II™ to show numbers and symbols for mmGPS 3D Paver functions.

LED

Light Emitting Diodes. These are the red lights seen on the faces of the PZS-MC Sensor, the PZL-1 Laser Transmitter, the 9168 Control Box, the Sonic Tracker II™, and the Laser Tracker.

M

Mat

The material being placed by a paver/finisher.

O

On-Grade

When a surface is at the selected elevation or slope, it is referred to as being on-grade.

Overlay

Paving over an existing mat.

P

Percent (%) Slope

The unit of measure used for cross slope.

S

Screed

The assembly behind the tractor. The screed strikes off, smooths and compacts the paving material into a semi-finished mat.

Slope

The incline of a paving surface perpendicular to the direction of travel expressed by stating the rise or fall of a percentage of horizontal distance (that is, 2% slope = 2" of elevation change in 100" of lateral run).

Slope Control

A means for controlling the transverse elevation of the fresh laid mat in relation to the grade.

Slope Sensor

An electrical device which detects positive and negative change in lateral elevation using the grade controlled side of the machine as a reference.

T

Thickness Control Screws

The adjusting crank located at the rear of each side arm, used to control the angle of attack of the screed.

Tow Points (Pull Points)

The points where the side arms of the screed are attached to the Tractor unit.

Transverse Beam

A steel bar connected to the side arms of a screed for mounting the Slope Sensor.

Temperature Bail™

A wire frame added to the Tracker that acts as a fixed target to compensate for rapid air temperature changes.

W

Wave

Long repeating changes in the elevation of the mat surface.

Working Window

Adjustable region of measurement used by the Sonic Tracker II™ to determine if elevation correction is required.

Notes:

Index

Numerics

2D Components
Sonic Tracker II **1-16**
Trackerjack Vibration Pole **1-17**
See also removable components **1-18**
2D control
machine configuration files **3-45**, **6-5**
setup **6-6**
2D Paving applications
Sonic control **6-1**
3D control
machine configuration files **3-45**, **6-5**
3DMC
about **3-86**
setup of **5-13**
3DMC buttons
back **3-11**
Cancel **3-11**
copy key **3-10**
delete key **3-11**
edit key **3-10**
New **3-10**
next **3-11**
Ok **3-11**
3DMC Functions **3-9**
3DMC Operations for Sonic Tracker Applications **6-7**
Creating a 2D Machine Configuration File **6-7**
9168 Control box
compact flash card slot **3-6**
control box front panel **3-2**
9168 control box features **3-1**

A

A and B point measurements **3-32**
About 3DMC **3-86**
Adjust slope **5-15**
Alignment files
and grading **3-51**
display options **3-40**
Angle of attack **4-2**
Antenna
and MC-2.5 LEDs **1-11**
radio **1-14**, **5-10**
Authorization codes **3-86**
Automatic control
Simple A/M Knob control **1-15**
Automatic mode
and paving **6-17**

B

Background, change color **3-43**
Base quality **4-13**
controlling mat **4-14**
differential compaction **4-13**
rolling techniques **4-14**
Base station
LEDs **2-8**
Quick setup checklist **5-2**
Base Station Initialization
steps to **2-9**–**2-10**
Base Station Kit
GPS Vibration Pole **1-7**
GPS+ Receiver **1-4**
PZL-1 Laser Transmitter **1-4**
PZS-1 Sensor **1-4**
PZS-MC Sensor **1-6**
Base Station Setup Rules **2-11**
Benchmark **3-61**

C

Change
- color **3-25**
- radio channel **3-63**
- units **3-71**

Change the light bar scale **3-75**
Changing Offsets
- using the Elevation Control key **3-79**

Checking mat depth **4-4**, **6-17**
Clear NVRAM **1-13**
Components **1-2**
- slope sensor **1-7**

Connectors **3-8**
- 3D GPS+ **6-5**
- base station **2-7**
- Sonic Tracker II **6-3**

Control box **3-2**
- 9168 control box **1-9**
- apply new codes **3-86**
- authorization codes **3-86**
- operation **3-2**
- options **3-86**
- setup of **5-12**
- viewing and updating **3-86**

Control menu **3-13**
Control methods
- Sonic Tracker II **5-29**

Control point
- accuracy **3-20**, **5-19**
- localization **3-20**, **3-21**, **5-20**
- location **3-20**, **5-19**

Control point files
- control box **3-15**–**3-17**

Controlling Mat Quality **4-14**
Cooling fan **3-7**
Coordinates
- elevation reference **3-30**, **3-34**
- GPS **3-17**
- NEZ **3-16**, **3-30**, **3-34**

Copy files **3-10**
Creating a 2D Machine Configuration File **6-7**
Creating a flat plane surface **3-28**
Creating a Linework File **2-27**
Creating a Machine Configuration **3-47**
- Configuration name **3-47**
- Location **3-47**
- Machine type **3-47**
- Radio information **3-49**
- Type of antenna **3-47**
- Units of measure **3-47**

Creating a sloping plane surface **3-30**
Cross slope **5-15**
- adjust **5-15**, **5-15**–**5-16**

Crossfall grade **3-33**
Cut/fill **3-76**
- *See also* Offset
- adjust elevation **3-78**
- and grade indicator **3-74**
- change **3-80**, **3-81**
- grade indicator **3-73**
- in from edge **3-74**
- left edge **3-74**
- negative **3-80**, **3-81**
- offset **3-78**
- positive **3-80**, **3-81**
- reading **3-78**
- section view **3-66**, **3-67**, **3-70**

D

Delete files **3-11**
Design elevation **3-76**
Design surface **3-24**
Design surface file
- create plane model **3-29**–**3-30**, **3-31**–**3-34**, **3-35**–**3-37**, **3-37**–**3-39**

Display **3-71**
- alignments **3-40**
- boundaries/breaklines **3-25**
- contours at intervals **3-25**
- linework **3-41**, **3-51**
- points **3-42**
- polylines **3-51**
- triangle mesh **3-25**

Display Options **3-71**
Dozer
- cross slope **5-15**

E

Edit files **3-10**
Editing a Plane Surface File **3-27**
EIM **1-12**
    LED blink indications **1-13**
Elevation
    adjust for 3D **3-78**
    adjust in 2D **3-79**, **3-89**, **3-90**
    key **3-76**
Elevation reference **3-74**
Elevation reference point **3-30**
Equipment Setup
    machine components **5-6**
Equipment Setup and Calibration **5-3**
    PZL-1 transmitter **2-12**, **5-3**

F

FC-100 **1-6**
Files **3-13**
    copy **3-10**
    delete **3-11**
    design surface **3-24**
    edit **3-10**
    new **3-10**

G

GPS coordinates **3-17**
GPS information **3-82**–**3-85**
    planning **3-85**
    screed edge position **3-83**
    status **3-83**
GPS Localization **3-19**, **5-18**
GPS mask angle **3-84**
GPS status
    mask angle **3-84**
    receiver ID **3-84**
    satellites **3-84**
Grade adjustment knob operation **3-4**
Grade indicator **3-67**, **3-69**, **3-75**
    and elevation reference **3-74**
    and offset change **3-73**
    change **3-73**
    change extents **3-75**
    change on-grade **3-75**
    cut/fill **3-73**
    display **3-68**
    purpose **3-73**
Grade indicators **3-3**

H

Head of material, force M **4-5**

J

Joystick
    operation **3-81**

K

Keyboard
    connect using USB **3-7**
    pop-up **3-11**

L

Laser
    height **5-24**
    location advice **5-24**
Laser control
    above grade **5-30**
    below grade **5-31**
    on-grade **5-30**
    receiver **5-30**
    transmitter **5-30**
LEDs **1-14**, **2-8**, **2-10**
    on MC-2.5 **1-11**
Light bar **3-71**
    and alignment file **3-71**
    display **3-14**, **3-69**
    steer to polyline **3-51**
Linework **3-41**–**3-42**, **3-51**
    display options **3-41**
Localization
    See also Control point
    with third party coordinates **3-21**, **5-20**
Location **5-24**
    large project **5-25**

small project **5-24**
working distance **5-24**
working height **5-24**
Lock slope **3-89**

M

Machine Components
9168 control box **1-6**
calibration of **5-15**
Slope Sensor **1-7**
Machine configuration files **3-45**–**3-50**, **6-5**
Machine orientation **3-65**
Main screen components
display **3-9**
elevation control key **3-10**
slope control key **3-10**
Topcon logo key **3-10**
zoom in **3-10**
zoom out **3-10**
Manual control
Simple A/M Knob control **1-15**
Manual mode
and paving **6-21**–**6-22**
Mask angle **3-84**
Mat depth **4-4**, **6-17**
Mat surface **4-4**
MC-2.5 Receiver Box **1-10**
setup of **5-11**
MC-2.5 receiver box **1-11**
clear NVRAM **1-13**
EIM mode **1-12**
LEDs **1-11**
normal mode **1-12**
Measure
cutting edge **5-15**
points for plane surface **3-30**, **3-32**–**3-34**
sensor on blade **3-47**
Menus **3-12**–**3-14**
Control **3-13**
File **3-13**
pop-up **3-92**
Tools **3-13**
Mix characteristics
gradation **4-9**
segregation **4-9**
temperature **4-11**
mmGPS Components
Base Station Kit **1-3**
mmGPS Control **5-23**

N

New files **3-10**
NEZ coordinates **3-16**, **3-30**, **3-34**
NVRAM **1-13**
clearing **1-13**

O

Offset **3-76**, **3-78**
change **3-80**, **3-81**
On-grade **3-3**

P

Paver Components **4-1**
Paver machine
and truck exchange **4-6**
components **4-1**
forces **4-5**–**4-12**
Paving
using cross slope **6-18**
using sonic control **6-19**
Paving Intersections
Method 1 **6-21**
Method 2 **6-22**
using cross slope **6-24**
Paving Principles & Control Methods **4-1**
PDL radio **1-10**
placement **5-24**
Placing Transmitters at the Jobsite **5-24**
Plane surface
edit **3-27**
see Design surface
Planing angle **4-2**
Pocket-3D **1-5**, **1-6**
units **2-1**

Points
display **3-43**
Polylines
steer to **3-51**
Position check **3-61**
purpose **3-61**
power switch **3-8**
PZL-1 Transmitter
setup in 3DMC **3-54**, **5-14**
PZL-1 transmitter information
copying **3-55**
PZS-MC sensor
Change settings **3-53**

R

Radio
antenna installation **1-14**, **5-10**
base station **2-2**, **5-2**
change channel **3-63**
connection tip **3-64**
LED **2-10**
licensing **A-3**
PDL **1-10**
select channel **2-8**
signal **1-11**
Teledesign **1-10**
usage **A-3**
Range **C-1**
Reaction of material under screed **4-8**
Reaction of material, force R **4-5**, **4-8**
Receiver
mask angle **3-84**
reset **3-84**
Receiver ID, GPS **3-84**
Reference elevation **3-76**
Regulatory information
Canadian Emission Labeling Requirements **C-3**
FCC rules **C-2**
UHF Radio Usage **C-1**
WEEE Directive **C-4**
Resection
function of **2-28**
measurement parameters **2-29**
performing **2-28**
Reset receiver **3-84**
Right window **3-68**
See also Views

S

Satellites **3-85**
Satellites, GPS **3-84**
Screed
and angle of attack **4-2**
measure slope of **5-15**
operation **4-2**–**4-5**
Screed tilt
measuring w/ slope sensor **1-7**
Selecting a Control Point File **3-15**
Selecting a machine configuration **3-46**
Sensors
calibration **5-15**
Slope
control **5-26**–**5-27**
gain **3-89**, **3-90**
key **3-88**
green **3-88**
red **3-88**
locked **3-89**
measuring **1-7**
Slope control system
calibration **5-15**
Slope sensor **1-7**–**1-8**, **5-26**
Sloping plane surface
creating **3-30**
Sonic Control Setup
Attach the Sonic Tracker **6-2**
Set up 9168 Control Box **6-5**
Sonic Tracker Applications
change elevation side to slope **3-92**
change slope side to elevation **3-92**
changing control methods **3-92**
Elevation Offset **3-87**
Locking on-grade **3-87**
slope offset **3-91**
Sonic Tracker II
control method **5-29**
transducer cleaning **6-9**

transducer replacement **6-10**
Specifications
Blade Slope Sensor **B-3**
Control Box **B-1**
GPS vibration pole **B-8**
MC-2.5 Receiver **B-5**
PZS-MC sensor **B-7**
Simple Auto/Manual Knob **B-4**
Sonic Tracker II™ **B-13**
Trackerjack **B-12**
Trackerjack Vibration Pole **B-9**
Steer indication
steer to polyline **3-51**
Steering options **3-52**
point of interest **3-52**
Subgrade road
creating **3-37**–**3-39**
Maximum extension **3-39**
Surface
plane, edit **3-27**
Surface Files
Creating a Flat Plane Surface **3-28**
Flat plane surface **3-24**
Raise/lower existing surface **3-24**
reference surface **3-23**
Sloping plane surface **3-24**
Subgrade of existing road **3-24**
Survey
see also Topographic survey
System range **C-1**

T

Teledesign radio **1-10**
Test **1-12**
EIM **1-12**
Tools menu **3-13**
Topcon logo **3-12**
Topo survey
display points **3-43**
Topographic survey **3-59**–**3-61**
stop **3-61**
Touch screen display **3-5**
Tow point **4-2**
force P **4-5**
P force **4-5**
Tow point force
truck exchange **4-5**
Tow point path **4-2**
Transmitter
setup information **2-14**, **5-5**
to add **2-14**, **5-5**
to calibrate **2-14**, **5-5**
to delete **2-14**, **5-5**
Transmitter adjustment **2-32**
Transmitter height
check **2-31**
TX Calibration **2-33**

U

UHF usage **C-1**
Units **2-1**, **3-71**
USB **3-7**

V

Valve gain **3-89**, **3-90**
adjust **3-81**
speed **3-89**, **3-90**
Valve offset **3-57**, **5-16**
calibration **3-57**–**3-59**, **5-17**–**5-18**
factory preset **3-57**, **5-17**
Views **3-14**–**3-67**
grade indicator **3-69**
Plan view **3-65**
profile view **3-66**
right window **3-68**
section view **3-66**

W

Warranty Terms **D-1**
Warranty terms **D-1**
Weight of screed, force W **4-5**, **4-12**
Working distance **5-24**
large project **5-25**
small project **5-24**
Working height **5-24**
Working surface

definition **3-23**
display options **3-25**

Notes:

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